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COMMUNICATIONS

TO THE

BOARD OF AGRICULTURE;

ON SUBJECTS RELATIVE TO

THE HUSBANDRY,

AND

INTERNAL IMPROVEMENT

OF THE COUNTRY.

VOL. II.

THE SECOND EDITION.

Omnium rerum, ex quibus aliquid acquiritur, nihil est agricultura melius, nihil uberius, nihil dulcius, nihil homine libero dignius. Cic. de Offic. I. c. 42.

LONDON:

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FOR G. AND W. NICOL, BOOKSELLERS TO HIS MAJESTY,
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AND SOLD BY MESSRS. ROBINSON, PATERNOSTER-ROW; J. ASPERNE, CORNHILL; CADELL AND DAVIES, STRAND; W. CREECH, EDINBURGH; AND J. ARCHER, DUBLIN.

1805.

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PREMIUMS

OFFERED BY

THE BOARD OF AGRICULTURE,

FOR 1800.

No. I.

To the person who shall draw up and produce to the Board, the best, simplest, and most practicable plan for ameliorating the condition of the labouring poor of this kingdom, by alterations in the poor laws, of easy execution, and without materially increasing poor rates—— *the Gold Medal.*

To be produced to the Board on or before the first Tuesday in March, 1801.

No. II.

To the person who shall build on his estate the most cottages for labouring families, and assign to each a proper portion of land, for the support of not less than a cow, a hog, and a sufficient garden——*the Gold Medal.*

Accounts of the expences ot building—land assigned—culture, if any—live stock, and state of the families, with the rent paid—verified by certificates to be produced to the Board on or before the third Tuesday in April, 1802.

No. III.

Doubts having been expressed by some persons concerning the expediency of cottagers keeping cows, except on rich soils; the Board will give to the person who shall produce the most satisfactory account, verified hy experiments, of the best means of supporting cows on poor land, in a method applicable to eottagers——*the Gold Medal.*

Accounts to be produced of the soil—articles cultivated—produee—stock kept—and every material circumstance—verified by certificates, on or before the first Tuesday in May, 1801.

No. IV.

To the pesons who shall make the most satisfactory experiments tending to the improvement of the cultnre of each of the following plants respectively, viz. wheat, rye, barely, oats, pease, beans, tares, buckwheat, turnips, cabbages, rutabaga, potatoes, carrots, parsnips, clover, lucerne, saiufoin, ehichory, hemp, flax, hops——*the Silver Medal.*

Accounts, verified by certificates, to be produced on or before the second Tuesday in May, 1802.

The same Premium for 1803.

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No. V.

To the person who shall draw up, and lay before the Board, the best memoir on the means of obviating the objections which have been made to a general inclosure act, in such manner as to facilitate such a measure, whenever it may be had recourse to——*the Gold Medal.*

To be produced on or before the third Tuesday in January, 1801.

No. VI.

To the person who shall draw up, and produce to the Board, the most satisfactory memoir on the best means of preventing future scarcities——*the Gold Medal.*

To be produced on or before the second Tuesday in March, 1801.

No. VII.

To the person who shall build and describe to the Board the cheapest cottage, being at the same time durable and comfortable——*the Gold Medal.*

A plan, elevation, and account of the materials and expence, verified by certificates, to be produced on or before the first Tuesday in May, 1801.

No. VIII.

To the person who shall invent and execute in a manner applicable to common use, the best and cheapest substitute for leather, in the shoes of the labouring poor, being an improvement on any, that may at present be in use——*the Gold Medal.*

A pair of shoes, with an account of the materials and expence, to be produced on or before the first Tuesday in December, 1800.

No. IX.

To the person who shall, through the entire summer of 1800, keep the greatest number of cattle in stalls, houses, or confined yards, and fed entirely in the soiling method with green food——*the Gold Medal.*

Certificates of the number of cattle, and acres of food, and sorts eaten, the quantity of dung made, with other circumstances of the experiment, to be produced on or before the first Tuesday in December, 1800.

The same Premium for 1801.

No. X.

To the person who shall improve, and bring to the annual value of not less than 10s. an acre, the greatest number of acres heretofore waste, not less than fifty——*the Gold Medal.*

Accounts of the improvement, verified by certificates, including the state of the land before the experiment, and of the cultivation, expences, and produce, to be laid before the Board on or before the first Tuesday in March, 1803.

Notice of the intended improvement to be sent to the Board.

No. XI.

To the person who shall lay before the Board the most satisfactory account of one of Mr. Elkington's drainages——*the Silver Medal.*

The soil and state of the land before draining, the method and expence of the improvement, with a plan and the result of the operation, to be produced on or before the second Tuesday in December, 1800.

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No. XII.

To the person who shall, by a series of the most satisfactory experiments, ascertain the omparative advantages and disadvantages of folding sheep——*the Gold Medal.*

Accounts, verified by certificates, to be produced on or before the first Tuesday in April, 1803.

No. XIII.

To the person who shall, in a country where Irrigation is not generally in practice, water the greatest number of acres, and in the completest manner—*the Gold Medal.*

Accounts of the old and new state of the land and value, the method, expence, and produce, verified by certificates, to be laid before the Board on or before the third Tuesday in January, 1802.

No. XIV.

To the person who shall make and report to the Board the most satisfactory experiments on the comparison of horses and oxen, in the general business of a farm——*the Gold Medal.*

The account, verified by certificates, to be produced on or before the last Tuesday in April, 1803.

No. XV.

To the person who shall, from authentic documents, and actual enumeration, report to the Board the most satisfactory account of the houses, and the present and past population, of any hundred, district, wapentake, or division of country in Great Britain, containing not less than ten contiguous parishes——*the Silver Medal.*

To be produced on or before the last Tuesday in April, 1801.

No. XVI.

To the person who shall give the most satisfactory account, verified by experiments, of the effect of ploughing in green crops for manure——*the Gold Medal.*

Accounts, with certificates, to be produced on or before the first Tuesday in March, 1802.

No. XVII.

Potatoes and wheat, in constant succession, being the course of crops which affords the most abundant food for man, the Board will give to the person who shall make and report the most satisfactory experiments on not less than five acres cultivated in that course during four years ——*the Gold Medal.*

Accounts of the soil, culture, produce, application, or price, verified by certificates to be produced on or before the first Tuesday in May, 1804.

The same Premium will be given (but not to the same person) for the same account of six years.

Accounts to be produced in May, 1806.

No. XVIII.

To the person who shall lay before the Board the most satisfactory account, verified by chemical experiments, or other sufficient authorities, of the nature of manures, and the principles of vegetation——*the Gold Medal.*

To be produced on or before the first Tuesday in December, 1800.

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No. XIX.

To the person who shall lay before the Board the most satisfactory account of the application and effect of manures, verified by practical experiments on not less than one acre for each sort of manure——*the Gold Medal.*

To be produced on or before the first Tuesday in December, 1802.

No. XX.

To the person who shall lay before the Board the most satisfactory paper on the means of ascertaining the probable state of the weather, so as to furnish useful information to the husbandman——*the Silver Medal.*

To be produced on or before the third Tuesday in May, 1801.

No. XXI.

To the person who shall give the best account, with drawings of the various instruments of husbandry——*the Gold Medal.*

To be produced on or before the first Tuesday in April, 1801.

No. XXII.

To the person who shall consent to his tenant applying the greatest quantity of old pasture land for the cultivation of early potatoes, (and the land so applied) which shall be brought to market and sold before the end of July, not less than 50 acres——*the Gold Medal.*

Accounts, verified by certificates, to be produced on or before the first Tuesday in November, 1800.

No. XXIII.

The Board having received information that the labouring poor on the estates of several persons in Rutland and Lincolnshire, having land for one or two cows, and a sufficiency of potatoes, have not applied, in the present scarcity, for any parochial relief; and it appearing to be a great national object to spread so beneficial a system, the Board will give to the person who shall explain, in the most satisfactory manner, the best means of rendering this practice as general through the kingdom as circumstances will admit.——*the Gold Medal.*

To be sent to the Board on or before the first Tuesday in November, 1800.

GENERAL CONDITIONS.

1. The Board reserves to itself the power of withholding any Premium when the communication or communications are not deemed sufficiently important to merit the reward.

2. The MS. &c. sent in claim of Premiums, to remain the property of the Board.

3. All memoirs, &c. sent in claim of Premiums, to be without names; with a mark or number; and accompanied by a sealed letter, on which is writen the same mark or number, and containing the name and address of the claimant; not to be opened unless the Premium is adjudged to that mark or number.

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COMMUNICATIONS, &c.

I. *Observations on the various Modes of inclosing Land. By* Robert Somerville, *Esq. of Haddington.*

Preliminary Observations.

Inclosing has long been considered, and very justly, not only as a certain means of improving waste and uncultivated lands, but also as an essential requisite to the completion of improvements upon the best soils, and such as have been long under tillage. For, whatever care or expence may have been employed in *clearing*, *draining*, *tilling*, *manuring*, *weeding*, &c. the whole of the benefits resulting from these can never be completely united, while the soil remains in an open uninclosed state. When the fields are in grass, they cannot be pastured to advantage without fences; and when they are in tillage, the crops, of whatever kind they may be, are exposed to every injury that can be suffered from the encroachments of sheep, cattle, or other animals.

In many of the counties throughout Great Britain, the features of this improvement are strongly marked, and the ideas of shelter, ornament, and increased produce, are visible to even the most superficial observer, and afford a very just comparative estimate of the advantages to be derived from inclosing, by contrasting the value of lands that are inclosed, with others of the same quality, that still remain in an open-field state; the saving in point of labour, the perfect security to the crop while the lands are under tillage, together with the warmth and shelter afforded to the stock and herbage, when the fields are in pasture, form a striking contrast, when compared with the open, unsheltered, unprotected, and unproductive state of uninclosed fields.

Obvious as these advantages are, it is to be regretted, that the system of inclosing, has, in too many instances, met with much opposition; and even in those cases where its benefits are clearly ascertained, much difference of opinion still exists, with regard to the nature of the fences requisite for *different* situations, the materials or plants that should

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be used, the best mode of executing them, and the season of the year most suitable for doing the work.

The opposition so often made to bills of inclosure brought into parliament, is a very striking proof of the former, and the little judgment that is shewn in accommodating the fence to the natural circumstances of the fields to be inclosed, is conclusive as to the latter. It too often happens, that proprietors and farmers, without duly considering either the nature of their soil, or its local situation, resolve upon, and adopt a mode of inclosing, which they have seen successful in other places, without once considering that the soil, climate, and other circumstances, which combined to render the plan successful in the situations they wished to copy, are totally wanting in theirs. Owing to this, much money is often expended, and many attempts prove abortive; the system of inclosing falls into discredit; and is considered as impracticable in many cases, where good and lasting fences might be reared at the same, perhaps less, expence than such as have failed. The reason commonly assigned, is the rigour of the climate, while the true and only cause is, the ignorance, or want of discernment in the persons who make these unsuccessful attempts.

The mistakes committed in this way are innumerable. Sometimes live fences are planted in situations, and upon soils, where it is impossible they can grow, far less arrive at perfection; and where substantial stone fences could be made, not only at little expence, but the building of which, by collecting the stones, would rid the adjoining surface of a nuisance, and remove an incumbrance which too often constitutes a material bar to its cultivation. The discernment necessary to discover this is not great; notwithstanding which, we too frequently have occasion to observe large fields inclosed, either with *dwarf, crabbed*, ill grown hedges, and rotten decayed palings, or with turf or earthen mounds, obtained by paring off the best part of the surface soil, while the fields (thus wretchedly inclosed, by fences, which, on account of their inutility and perishable nature, must one day be abandoned) are covered with numerous large stones, the removal of which is an essential requisite to their improvement. The same circumstance often happens where live fences might be reared, which, in every instance where they can be brought to perfection, are to be considered as preferable to every other. In place of making the hedge with such plants as are suited to the soil and climate, they are often directly opposite, dwarf, stinted, white-thorn hedges being very frequently seen upon cold wet lands, and in bleak exposed situations; upon which, if *beech, black-thorns*, or *crabs*, had been planted, they would have

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grown readily, and made complete fences in a very short time. In other instances, the fence fails, or becomes faulty, from circumstances which the planter may be disposed to consider as immaterial. For example, in inclosing a large field, a great part of the outline of which is wet, if white thorns are planted in the ordinary way upon the common surface they will never make a good fence; whereas by planting them in the face of the bank of earth thrown out of the ditch, being thus raised above the level of the field, and placed upon a dry bed, they thrive, and soon establish themselves: while upon very dry lands, with open bottoms, that possess little capacity for retaining moisture, the hedge very often dies, from an opposite cause; when the plants are set upon the mound raised above the common surface, if the season is but commonly dry, their growth is considerably impeded from the want of moisture; and in severe winters, from the porous nature of the soil, the frost gets access to the roots, and either kills whole rows or lines of hedges in a few weeks, or so far hurts them as to check their future growth.

In perusing the different County Reports, the whole of the surveyors concur in opinion as to the utility of inclosures; but it is mentioned by several of them, in terms of regret, that the obstacles thrown in the way of this valuable improvement, by ignorance and obstinacy, are great and manifold. In some cases they speak in terms of the highest panegyric of the utility, cheapness, and durability, of certain fences, such as *quicks*, *beeches*, *crabs*, &c. when they are planted upon the soils to which they are respectively the best adapted: while in others, they mention, in pointed terms, the perishable nature and transitory value of many of the fences employed; the annual expence required to keep certain descriptions of them in repair (the dead hedges and palings), and the great extent of valuable ground that is occupied by the others; especially the inclosures made by double ditches with a bank between them, and a hedge on each side; and of the common hedge and ditch, and hedge and bank, which, at the same time that they occupy a considerable space of ground, are very seldom good fences: in some instances covering thrice, and in others four times, the space, that a fence of a different kind would do, if properly kept. Great contrariety of opinion also prevails in regard to making trees a part of the inclosure, either in hedge rows or belts of planting: from such diversity and opposition of sentiment, it is difficulty to form any fixed or certain opinion upon the subject. Without pretending to offer arguments that will either inform ignorance, or remove prejudice, it is proposed in this Paper, to present the reader with a detailed account of the various fences now in use, as collected from the different

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Surveys; and simply to state the method of erecting them to the best advantage, together with the advantages and defects of each.

It may not be improper, however, previously to state, the various points to which the proprietor or occupier, ought to pay particular attention, before he commences any plan of inclosure. These points are,

1st. The nature of the soil.

2d. Its present worth, and the increase of value expected from inclosing it.

3d. The objects to be attended to in making inclosures; and whether the greatest value of the fences is expected to arise from their simply confining the stock, or from their affording shelter to both stock and crop, or from the union of shelter and inclosure.

4th. The modes of inclosure suited to the natural circumstances of the soil, climate, &c.

5th. The materials for making the fences, and the means of obtaining them.

The expence, another important point to be considered, must depend upon so many local circumstances, that it is impossible to form any estimates that could be of much service.

In regard to the durability of the fences, and the shelter they respectively afford, some observations on those heads, will be laid before the reader, when the several sorts of fences are described.

Nature of the Soil.—A careful inquiry into the nature of the soil, seems to be one of those requisites essential to the success of every plan of inclosure; for though there are, comparatively speaking, few situations, however elevated above the level of the ocean, and scarce any description of soil, where a good live fence may not be reared, with one sort of plant or another; yet it is an object of the first importance, to know the plants best suited to every variety of soil; as, by a judicious choice of these, much loss and difficulty is avoided, and good substantial fences are made in a short time; and in many situations, where, from a mistake as to the plants employed, the fence has languished for years, and ultimately perished, nothwithstanding every care that could be bestowed upon it. In some instances, we have known twenty years experience, barely sufficient, to undeceive those who have made mistakes of this kind. In the few cases, however, where this obstinacy has given way to common sense and observation, and where the plants of which the hedge was originally made, have been taken up, and others better adapted to the soil substituted in their room, these last have, without much trouble, made a good fence in a very short space of time.

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When the plants commonly used in the formation of hedges come to be spoken of, an opportunity will be afforded, of detailing the different kinds, and the soil for which they are respectively best adapted, together with the means of managing them to the best advantage.

Present Value of the Soil, and probable Increase from inclosing it.—In every plan of improvement, whether by inclosing or otherwise, it is very material to ascertain the present worth of the estate, and the probable increase of value that may be expected from the undertaking; for unless this point is judiciously weighed, the operations will proceed at random, and much labour and expence may be incurred, without any adequate advantage resulting therefrom. . For much, and justly, as the advantages of inclosing are extolled (and they are unquestionably great), there are certain circumstances of soil and local situation, that bid complete defiance to this and every other attempt at improvement. For example, in high rocky situations, where the soil is not only thin, but of a bad quality, where the lands can never be subjected to the plough, and where the herbage is not likely to be much ameliorated by shelter, little benefit will be derived from inclosing. The only advantage resulting from the practice in such cases, seems to arise from the saving of a shepherd's wages, which, when the stock are pastured in an inclosed field, is rendered unnecessary; but which, if accompanied with no other advantage, will be found a paltry equivalent for the expence of inclosing the soil. On the contrary, however high or exposed the situation may be, if the soil is of a good quality, and a species of plants can be met with of a nature so hardy as to bear the climate, the value of the property will be so far improved by the shelter arising from the fence, as amply to compensate the expence incurred in making it. In many of the bleakest and most exposed situations in Britain, the soil, though greatly elevated above the level of the ocean, is equal in quality to what is met with even in the most favoured situations, and for the most part requires nothing but shelter, and judicious culture, to render it highly valuable. In detailing the different kinds of fences, especially that known by the name of hedge, and belt of planting, an opportunity will be taken of pointing out several instances, where this mode of inclosing has benefited the property so inclosed, in a tenfold proportion, in a very few years. Upon this point, it remains only to hint, that every person, whether proprietor or farmer, should, before he commences his operations, pay very particular attention to the present value of the property, in an uninclosed state, and the extent to which it may be improved by inclosing; as without such previous knowledge, in place of being repaid by the pleasure

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arising from seeing the property ornamented and improved in proportion to the trouble and outlay of money, large sums will often be expended, without adding to the general appearance of the country, or materially contributing to augment the value of the soil.

The Objects to be attended to in making Inclosures.—In some situations, all that is required is merely the confinement of the stock; in others, shelter to the stock and herbage is the principal object; but in a great majority of cases, the union of both is necessary, to complete the system of inclosing. In mild low situations, perhaps a stone wall, or a low thorn fence, will answer every purpose required, and produce every benefit that could be expected from the inclosure; yet these fences, would be found totally incompetent to the purposes of inclosure, in the hilly and upland parts of the country; for though confining the stock might be completely answered by either, the important requisite of shelter would be entirely wanting.

Other matters of equal importance ought to enter into the consideration of persons inclosing. The separation of the soils inclosed, so as to render that of each field as nearly as possible of an uniform quality; the separation of stock as may be thought most advisable, together with the securing a sufficient supply of good water, are requisites so essential to the success of the undertaking, as to entitle them to a high degree of attention. When that branch of the subject, the advantage arising from inclosures, comes to be considered, these will be dwelt upon at some length.

Modes of Inclosing suited to the natural Circumstances of the Soil.—This matter has been in some degree discussed in the preceding article. There cannot remain a doubt that the success of every attempt that is made in the way of inclosing, must in a great measure depend upon the discernment of the person who undertakes it. A material consideration in such cases, is to determine whether *live* or *dead* fences are the most eligible, or best suited to the natural circumstances of the soil. The former comprehends every fence made with growing plants; the latter includes not only the different kinds of *wall* or *dike* made with dry stone, stone and lime, stone and clay, turf, &c. but also the different kinds of dead hedges and palings: into this estimate ought also to enter, the comparative usefulness and durability of each, together with the first cost. In general the first class, *viz.* live fences, where the plants are properly chosen, and well adapted to the soil, are uniform in this respect, that under proper management, their value is yearly increasing; while that of even the best constructed dead fences, is annually growing less. Where they consist of dead hedges or palings, their decay is

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certain, and commonly rapid; and even when they are constructed with stone and lime, which are by far the most durable of that class, though they make perfect fences at once, and the proprietor or occupier enters into immediate possession of every advantage that can arise from them, yet from the hour they are built, their decay commences; and after the first few years, a regular and progressive expence is incurred to keep them in repair.

Fences suited to the Uplands.—In all upland situations, the first class of fences will be found the best: of that class however, the beech hedge, and hedge with a belt of planting, deserve a preference, as they unite in the highest degree the important requisites of shelter, ornament, and inclosure. The beech, under proper management, attains a great size even upon the poorest soils, and soon forms a useful fence, in situations, where thorns and other kinds of hedge plants would either perish, or remain in a dwarfish state; with this additional material advantage, that by keeping its leaves during the winter, it affords shelter to the stock and pasture at the most clement season, and when it is most wanted.

Fences adapted to the lower Parts of the Country.—In low situations again, where little is to be apprehended from the want of shelter, thorn hedges kept low, or any of the different kinds of stone walls, will answer every purpose: and as the soil, in these low situations, is for the most part of very great value, those fences, from the little space they occupy, will be found preferable to every other.

Materials for making Fences.—In the foregoing observations upon the modes of inclosing suited to the natural circumstances of the soil, we have pointed out what appeared the best, upon the supposition that the materials could be readily obtained at a reasonable price. In many situations, however, the scarcity and apparent want of many of these materials forms an almost insuperable obstacle to inclosing upon the plan above hinted at: for instance, in the remote parts of the kingdom, where the different kinds of trees and hedge plants are either very scarce, or not attainable but at an enormous price, it will often be found necessary, in the inclosing of upland districts, to surround the fields with stone walls in place of hedge or hedge and belt of planting; and in not a few situations in the low lands, where stone walls would be the most eligible fence, from the scarcity of that article, hedges, or hedge, and ditch, are had recourse to. Under such circumstances, necessity is the law, and the person inclosing must accommodate his plans to his resources.

It will, however, frequently happen, that the materials wanted will be met with upon

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the spot, not only without expence, but with much advantage to the property; as in cases where the fields are infested with stones, their removal will at once facilitate the improvement of the field, and furnish good materials for inclosing it. But even where the resources are less visible, and there are no stones upon the surface, by a careful examination of the substratum, plenty may be met with; or in defect of these, clay for making either bricks or mud-walls may be had merely for the trouble of digging.

With regard to the other kinds of dead fences, such as palings, dead hedges, &c. materials for constructing them may be procured in almost any situation, from the thinnings of young plantations, from coppices, and the cutting down of old hedges; even the deficiency of hedge plants and young trees might be, in a great measure, if not entirely, got the better of, if every proprietor were to have a small nursery for raising them for his own use, and that of his tenants. To the convenience and saving of expence, with which this practice would be attended, we have to notice an unspeakable advantage, *viz.* that arising from the use of plants propagated in, and inured to the climate where they are afterwards to grow. It must require little knowledge of the subject to convince any one, that plants of whatever kind, reared in the upland and hilly parts of the kingdom, will thrive better than such as have been reared in the warmest and most sheltered spots. To what are we to ascribe the amazing size, and luxuriant growth, of many trees in the Highlands of Scotland, or even in Norway, and North America, but to the circumstance of their having come into existence, in the climate and situation where they were afterwards destined to grow; and by being thus early inured to the climate, became, to all intents and purposes, indigenous.

Plants suited to the Soil.—It is not the least important consideration with persons inclosing, after having determined whether live or dead fences should be used, to make choice of the plants best suited to the soil. In the flat low parts of the country, where the soil is loamy, or gravelly, and at the same time moderately dry, and not greatly exposed to any prevailing wind, white thorns will be found both the cheapest and the best. Hazel, elder, and a multitude of others might be used for that purpose in these situations; but, as we shall afterwards have occasion to remark, they are liable to objections which the thorn is not. If in these low situations, it is meant to plant trees along with the fence, either in hedge rows or belts, the dry soils should be planted with *oak, ash, elm, plain tree, chesnut, beech,* &c. and the moist parts with poplars, and the different kinds of willows; by such means the whole will thrive, and in a short time become valuable to the proprietor. In the upland and hilly parts of the country, unless

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the soil is very wet indeed, the hedge plants should consist either entirely of beeches, or a mixture of beech and larch; the last is known to answer well in these exposed situations, and not only endures plaiting and clipping without injury, but thrives remarkably under these operations; where the soil however is wet or spongy, a different description of plants should be used; willows of different kinds, *poplars*, birch, or allar, will then be found the best, and ought, in preference to every other, to be made use of.

By thus adapting the plants to the soil and climate, few plans of inclosure will prove abortive in any situation.

Having premised these general observations, we shall now proceed to consider the present state of Great Britain in regard to inclosures.

From the perusal of the different Surveys now in possession of the Board of Agriculture, it appears, that in almost every county throughout the kingdom, considerable tracts of the soil are inclosed; and that many plans of additional inclosures, to a very considerable extent, are now in contemplation.

The surveyors appointed by the Board are unanimous in their approbation of the system, which they represent as so beneficial in its consequences, that in many cases the value of the property has been thereby increased in a fourfold proportion, and in some well authenticated instances, considerably more.

The fences at present in use, are of great variety; and a part of them, particularly such as have been made of late years, executed in a handsome substantial manner, uniting at once the important points of *shelter*, *inclosure*, and *ornament*.

The appearance of these, owing to the judicious manner in which they are managed, convey to the mind the strongest ideas of permanent and valuable improvement.

The different kinds of stone walls, by having a broad foundation sunk deep enough in the earth, to place them beyond the reach of frost, tapering gradually upwards, and secured at top with a proper coping, are found to last many years, with but very slight repairs.

The hedges, from the circumstance of their being planted at a proper season, the plants made use of adapted to the nature of the soil, and afterwards kept in order by regular weeding and trimming, are of immense value, and form the most beautiful and lasting fences that can be imagined.

Many other descriptions of fences are equally perfect and valuable; but though these circumstances are mentioned with much satisfaction, and must give pleasure to every person who feels, or has the smallest interest in the improvement or welfare of his

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country, it is with pain we remark, that in too many instances, the system of inclosing is extremely defective; and much less solicitude has been shewn to secure and unite the whole of the benefits to be derived from it, than the importance of the subject deserves.

To confine the stock, seems in too many instances to have been the sole object, while the weightier matters of *shelter*, both for the *stock* and *pasture*, *separation of soils*, *separation of stock*, and many other points of equal importance, have been entirely overlooked.

In too many instances, no attention has been paid to the natural circumstances of the soil intended to be inclosed. High inaccessible walls, belts of planting, and hedgerows of trees, being very often met with in the lowest and warmest situations, where little or no shelter is necessary; while in the hills and uplands, and along the sea coast, where shelter is indispensable, both for the *stock* and *pasture*, and where its advantages are incalculable; the fence very often consists of a naked stone wall, which though it may, and indeed does, answer the purpose of confining stock, possesses no other advantage; and many tracts of immense extent, the value of which might be improved in a tenfold proportion, by hedges and belts of planting, exhibit a naked bleak appearance, and continue exposed to every blast.

The loss and disadvantage attending this injudicious mode of inclosing are strikingly obvious. In the low warm parts of the country, where the land is of immense value, much of it is occupied by fences which the nature of the situation does not require, while in the more elevated and exposed parts, where shelter is the *sine qua non* of improvement, and where the land occupied by the fence is, comparatively speaking, of small value, the fence, in place of affording the necessary shelter both to the stock and pasture, is barely adequate to the purpose of inclosing the field.

Under such circumstances, the pasture will for the most part be scanty: and neither a breeding nor a feeding stock, will make half the progress upon it, that they usually do, in cases where they enjoy the benefit of complete shelter.

A defect equally injurious to the proprietor or occupier, and highly inimical to permanent improvement, seems to prevail in the choice of the materials of which inclosures are generally made. In every instance where circumstances will admit of it, present use ought, if possible, to be united with durability, in the formation of every fence; an attention to this, is too often totally wanting, both with proprietors and farmers. Provided the present purpose is answered, future consequences are disregarded: and neither

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a knowledge of the perishable nature of the materials made use of, which daily experience presents to their view, nor the frequent and heavy expences to which they are put for repairs, have been sufficient to make them alter their system. Amongst these perishable fences are to be ranked, the different kinds of earthen and mud-walls, of turf, of turf and stone, together with the whole of the wooden fences, comprehending the different kinds of paling and dead hedges.

The ancient custom of inclosing fields with high earthen banks, or mounds, sometimes with, and sometimes without a paling on the top, which prevailed formerly in many parts of England, and which is now pursued in the North of Scotland, though it did very well as a rude essay in the way of improvement, when other modes of inclosing were either unknown, or imperfectly understood, and might for a time answer the purpose, either of confining the grazing stock, while the field was in pasture, or protecting the corn crops when it was under tillage, is perhaps the worst and most perishable of all fences. After being reared with much labour, and committing a theft upon the adjoining surface, which is pared off to a considerable distance on each side, it remains but a very few months, or even weeks, in a perfect state: indeed from the moment it is made, it begins to decay; and the operation of the weather upon it, for a few years, renders it useless as a fence. Accordingly, in many parts of the Island, we meet with the remnants of such fences, which, though they were originally of considerable height, and to appearance strong and formidable, are now so completely beat down, and levelled by the action of the weather, as to render it in some cases a matter of difficulty for the curious to trace their foundations, or the direction in which they formerly ran. The case is the same with walls formed entirely of turf, or a mixture of turf and stone. These, though made at considerable expence, and, as has been already noticed, by robbing the neighbouring surface, are equally perishable, as the simple earthen mound. Upon whole farms, and even estates, that were formerly inclosed with turf, or stone and turf walls, nothing now remains but their vestiges, which, while they exhibit a striking proof of their perishable nature, afford at the same time a salutary lesson to proprietors and others, to beware of such temporary expedients; as however cheap such fences may be in the first instance, in their best state they are but imperfect, and in the end are the worst and most expensive of any.

An equal defect prevails in many instances where the fence is entirely of stone. Where the walls, in place of having a good foundation, sufficiently removed beyond the reach of frost, broad at bottom, tapering gradually upwards, and finished at top

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with a substantial coping of flags, *stone and lime*, or turf, so formed as to prevent the decay of the building, are in many instances built upon the plain surface, with scarce any taper towards the top, and without any coping at all, except perhaps a slight one of turf, which soon moulders away, and, if the wall is built with lime or clay, permits the moisture to soak down and destroy it. The same improvidence and want of judgment discovers itself, in carrying these walls through every kind of soil, wet as well as dry. In the formation of extensive inclosures, it very often happens that a part of the line in which the fence is to run, is wet and spouty; in place of paying attention to that circumstance, discontinuing the wall where the dry land terminates, and either attempting to lay the spouty parts dry by draining, or plant a hedge of willows, poplars, or other plants adapted to wet soils upon the surface, the wall is too frequently continued through the whole. The consequence (as may very naturally be expected,) is, that the wall, for want of a solid dry foundation, soon tumbles down, or is continually needing repairs.

Along with this inattention to the shape of walls, considerable loss arises from building them with round, or what are termed land-stones. These, from their shape, are incapable of presenting a sufficient extent of surface to each other to bind them, or give stability to the building, by which means it seldom lasts long, though clay, or even lime is made use of. The expedient of mixing clay, is particularly inexpedient, as in general the first winter's frost, or a long continued series of wet weather, saturates the clay so completely, that the wall swells, bursts, and tumbles down.

The practice of inclosing with the different kinds of dead hedges and palings, is productive of equal loss, both to individuals and the community. Were these fences made to answer only a temporary purpose, such as protecting a young hedge, &c. &c. the loss would not be great, as their original value is small, and long before they were totally decayed, the hedges they were meant to protect would be so far advanced, as to make good fences without their assistance. From the perusal of the different Reports, however, it appears, that in many of the English counties, they are resorted to in cases where permanent plans of inclosing are intended, and are the only fence made use of. The surveyors who have noticed the practice are unanimous in their disapprobation of it, and represent the fences as perishable, and in the highest degree expensive. In several whole districts, dead hedges of different kinds form the only fence, and occasion an annual expence upon the property so inclosed, amounting from a fifth to a tenth part of the rent. Nearly an equal loss and expence is incurred in inclosing

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with paling; what adds to the regret that arises from the observation of this ruinous practice, the soil and climate, in most cases where it prevails, are well calculated for the growth of live fences.

It is evident, that what is said above will be considered by the public at large as a reproach, and will be felt as such by those concerned. We admit that the feelings of individuals ought, in every instance where it is compatible with the public welfare, to be respected; but where, either their opinions or practices are hurtful to the country, or hostile to its improvement, they are justly reprehensible. Forbearance in such cases is vice; and though exposing their faults may, in some instances, cover them with shame, yet the task is necessary; and, by fixing the attention of the public upon the subject, has very often the effect of preventing the most serious abuses, and bringing about valuable improvements. If any thing that is now mentioned, is conducive, in the smallest degree, to correct the faults in the system of inclosing above enumerated, or to change the perishable dead fences, for good quick hedges, the purpose of these observations will be fully answered.

Wet Ditches.—But to return to the subject. Where ditches constitute the fence, either in their simple state, or as making a component part of another fence, such as ditch and hedge, &c. due attention has in very few instances been paid to secure every advantage that might be derived from their use.

Defects of them.—Proceeding without judgment, the ditches in many counties are made equally deep and wide, upon wet and dry lands, from an erroneous opinion, that the drainage of the field, and the future prosperity of the hedge, require a ditch of certain dimensions. In place of laying off the field, in such a style, as to make the ditches subservient to the purposes of drainage, as well as inclosure, they are frequently dug at random, of an uncommon depth and width, with a high bank or mound of earth on the side next the field, so strong and thick, that no water can find its way through it. In that way, the ditch, in place of acting as an open drain for carrying off the water from the adjacent fields, acts as a kind of barrier to prevent it from getting away; while from the want of a proper level and outlet, when once filled, it becomes a kind of reservoir; and by continuing filled with water three parts of the year, chills the roots of the hedge plants so much, that they either perish entirely, or remain small, stinted, and diseased. In this place it may be necessary to observe, that the use of ditches, as open drains, has in many instances been completely misunderstood. In most of the old inclosures they were thought valuable, only in proportion to the quantity of water

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they were capable of containing, without considering whether they were so situated as to convey that water to a proper outlet. In the valuable and judicious Reports from the Counties of Ayr and Stirling (remarkable for their correctness and elegance), these deep and wide ditches are described, and their defects noticed: in the former county, they are from six to eight feet wide, and of a proportionable depth; and in the latter, they are in many cases upwards of twelve feet wide. The quantity of valuable ground occupied in that way, over such extensive districts, must be immense, and when to this is added, the injury done to the hedges from their roots being chilled, and the inconvenience arising from having a tract of country so much cut and intersected by these canals during winter, which prevents all passage through them, and the danger of their weak horses or cattle, or even unfortunate travellers, who mistake their road in the dark, falling into them (circumstances which unfortunately too often occur), together with the expence of making such deep excavations, it will readily appear, that the practice is bad, and that every purpose both of drainage and inclosure might be answered, at perhaps a fourth part of the expence, and without any of the risks or inconveniences we have mentioned. When we come to speak of ditches, notice will be taken of the proper mode of forming them, so as to render them subservient both to the purposes of drainage and inclosure, with the least possible expence.

Hedges.—In many parts, the defective method of rearing and managing the hedges is no less striking. In place of making the whole hedge of one kind of plants, suited to the nature of the soil, and such as, when arrived at a certain age, are capable of making a good fence, the inclosure is frequently surrounded with a motley mixture of shrubs, many of which, even in the most perfect state, are unfit for making a fence, while others, though they might have answered that purpose pretty well, if the whole fence had been made with them: yet from the circumstance of their being mixed with others, which not only come into leaf, but also shake their leaves at a different season, both hurt each other's growth, are offensive to the eye, and take from the general appearance of the country. Such, however, are the fences in some parts of the finest counties in England, where, upon the top of a high bank that has been raised by robbing the adjoining ground of its soil, a motley hedge, consisting of various plants, is met with, full of gaps filled up with stones or dead wood, forming a very insufficient fence, either for the purpose of confining the stock, while the field is in pasture, or of protecting the crops, while it is under tillage.

In other cases, where the plants of which the hedge consist are of one kind, it too

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often happens that they are by no means suited to the nature of the soil. For example, in inclosing a large field, where a part of the line of fence is perfectly dry, and a part of it wet and swampy, in place of planting quicks or white thorns upon the dry spaces, and willows, poplars, birches, or such plants as thrive in damp situations upon the wet parts, the whole field is often surrounded with thorns, greatly to the hurt of the proprietor and occupier; as upon the dry land the thorns thrive, and in a few years make a good fence, while upon the wet parts, they either fail entirely, or are good for nothing. Whereas, with a little judgment in accommodating the plants to the soil, planting quicks upon the dry land, and willows, poplars, &c. upon the spouty and swampy parts, the whole would thrive, and there would be no defect in the line of inclosure.

To this mistake (a want of judgment in accommodating the plants to the soil) is to be added, the defects which commonly take place in the after management and training of hedges. It is now well known, that the whole or the greatest part of the plants of which hedges are made, if left to themselves without pruning or weeding, runs up to a considerable height, grow broad and bushy at top, and become open and naked at bottom. To prevent this, there is no remedy known, but that of culling over the main stems of the plants, of which the hedge consists, after they have attained a certain height, and pruning or trimming the lateral branches in such a way, as to preserve the hedge thick and broad at the bottom, and give it a gradual taper towards the top.

But in place of this management, the hedge, in most instances, after being planted is abandoned to its fate; and neither weeding, pruning, nor indeed any other attention bestowed upon it: in that way, a number of the plants are either choked by weeds, or remain in a dwarf stunted state; and such as survive this usage, are allowed to shoot up at random, and soon attain a great height without being useful as a fence; and by the spreading of their branches at top, not only become naked and open below, but cover three times the space of ground that hedges differently kept usually do.

Having dwelt at some length upon this important branch of the subject, we shall now proceed to give a detailed account of the different fences at present in use, the mode of making them, together with their respective advantages and defects.

The following list comprehends the greater part, if not perhaps the whole of the fences at present in use in Great Britain.

It is proposed to divide them in two classes, namely, the simple and the compound: the simple fences consist of one kind only, such as a ditch, a hedge, a *wall* or *paling*, without the addition of any thing else; while the compound fences are made by the

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union of two or more of these, such as *hedge and ditch*, *hedge and wall*, *hedge and paling*, &c.

Simple Fences.

I. Simple ditch, with a bank on one side.

II. Double ditch, with a bank of earth between.

III. Bank of earth, with a perpendicular facing of sod.

IV. Ha-ha, or sunk fence.

V. Palings,* or *timber fences* of different kinds, *viz.*

1. Simple nailed paling of rough timber.
2. Jointed horizontal paling.
3. Upright lath paling.
4. Horizontal paling of young firs.
5. Upright ditto of ditto.
6. Chain fence.
7. Net fence.
8. Rope fence.
9. Flake or hurdle fence.
10. Osier or willow fence.
11. Fence with growing posts.
12. Shingle fence, horizontal.
13. Ditto upright.
14. Warped paling.
15. Open paling warped with dead thorns, or branches of trees.

VI. Dead hedges, various kinds.

VII. Live hedges.

VIII. Walls.

1. Dry stone wall, coped and uncoped.
2. Stone and lime ditto, coped and uncoped.
3. Stone and clay ditto.
4. Stone and clay harled, or dashed with lime.
5. Dry stone ditto, lipped with lime.
6. Dry stone ditto, lipped and harled.
7. Dry stone pirned and harled.
8. Brick walls.
9. Frame walls.

* Architects, surveyors, and builders, commonly apply the term pales, to sawn boards nailed vertically in fences, exclusive of the posts and rails. A paled fence therefore consists of three parts; 1st. posts; 2d. rails; and, 3dly. pales. It is only when the pales are nailed on to the rails, and the latter framed into posts which are fixed in the ground, that it is properly called a paled fence. In this work the word paling, however, is taken in a more extensive sense, implying timber fences in general.

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10. Galloway dike, or wall.
11. Turf walls.
12. Turf and stone in alternate layers.
13. Mud walls with straw.

Compound Fences..

1. Hedge and ditch, with or without paling.
2. Double ditto.
3. Hedge and bank, with or without paling.
4. Hedge in the face of a bank.
5. Hedge on the top of a bank.
6. Devonshire fence.
7. Hedge, with single or double paling.
8. Hedge, and dead hedge.
9. Hedge and wall.
10. Hedge, ditch, and wall.
11. Hedge in the middle of a wall:
12. Hedge and ditch, with row of trees.
13. Hedge, or hedge and wall, with belt of planting.
14. Hedge, with the corners planted.
15. Reed fence, or post and rail covered with reeds.

Having thus enumerated the different kind of fences, we proceed to a separate detail of each, their nature and advantages, and the best method of constructing them.

Simple Fences. 1st. of Ditches in General.—Though ditches now form a part of that class of fences which we term compound, yet in their simple and original state, they were considered rather in the light of open drains; and, in place of being looked upon as a fence, their greatest benefit was supposed to arise from their receiving, or carrying off the superfluous moisture from the inclosed field.

In a variety of instances, ditches are made for this purpose only, where there is no intention whatever to inclose the field. They are, however, sometimes meant as a fence: but in such cases they are made very deep, and wide; and the earth taken out of them is sometimes formed into a bank, the height of which, when added to the depth of the ditch, forms a tolerable barrier: in general, however, the greatest value of the ditch is met with, when it is used in conjunction with other fences, as will be seen under the second class,—compound fences.

Form of Ditches.—The form of ditches is very various, some of them being of a uniform width both at top and bottom; others are wide above, and have a gradual slope downwards; a third kind have one side sloping, and the other perpendicular. For whatever purpose the ditch is meant, the sloping form is by much the best; as it not only

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costs less money in the digging, but is at the same time much more durable, and has a neater appearance.

Where open ditches are indispensably necessary for the drainage of the field, the sloping ditch is preferable to every other; as the sides are not liable to tumble in or be undermined, or excavated by the current of the water, when properly executed. The slope should be considerable; perhaps not less than three times the width at top, that it is at bottom. When we come to speak of hedge and ditch, the advantages of this construction will be more particularly noticed.

The open ditch, with the wail or perpendicular sides, is liable to much objection, both in its simple and compound state: in its simple state, the sides are perpetually tumbling in, especially after frosts or heavy rains; and if the field round which these ditches are made has any considerable declivity, the bottom is undermined, and large masses tumble down, bringing the hedge along with them. These circumstances are of themselves sufficient to bring this kind of ditch into discredit; but while they are thus improper as open drains, owing to the circumstances we have mentioned, their shape is the best possible for a covered drain, as the broader these covered drains are at bottom, the more water will they carry off; with this additional benefit, that by being broad below, they are less liable to choking, or obstruction, than if they were narrow; in which case, a single stone or two clapping close together, will so far interrupt the course of the water, and so much sand and mud will accumulate behind them, as to render the drain useless: whereas, when there is a sufficient breadth at bottom, if the water is obstructed by one stone, it readily finds a passage elsewhere.

1. *Simple Ditch, with a Bank of Earth.* This fence is represented, Pl. I. fig. 1. and consists merely of a ditch, sloping gradually towards the bottom; the earth taken out of it, is generally formed into a bank on one side, leaving a scarcement, or projecting space, of six or eight inches on the side where the bank is formed, to prevent the earth from tumbling in, and filling up the ditch.*

2. *Double Ditch, with a Bank between.*—This fence is represented by fig. 2. Pl. I. It is not often that the double ditch is used, unless in cases where it is meant either to plant hedges, or trees, on the bank between the ditches: in some cases, however, double

* In place of which the figure represents the earth gathered into heaps, and smoking; explanatory of the practice in some of the English counties, of burning the clay taken out of ditches, and using it as manure.

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ditches are made, where there is no intention whatever of planting either hedges or trees, and in several instances are highly valuable.

Considered as a fence, it has an evident advantage over the single ditch; as the earth taken out of the two ditches, when properly laid up in the middle, forms a pretty steep bank of a formidable appearance; which, without any other addition, makes a very tolerable temporary fence.

For the purposes of open drainage, the double ditch is excellently adapted, especially by the sides of highways, where the lands have a considerable declivity towards the road; the ditch next the field, by receiving the water on that side, prevents it from overflowing and washing the road, a circumstance which very frequently happens in such situations; while the ditch on the side next the road, by receiving and carrying off the moisture that falls upon, and which would otherwise lodge there, and destroy it, keeps it constantly dry and in good repair.

The double ditch is also useful in dividing high, from low flat lands, particularly where the high grounds slope very suddenly down upon the low fields; that, next the high ground, by receiving the water from it during heavy falls of rain, saves the inferior grounds from inundation, while the ditch on the other side serves as an open drain for the lower fields.

We trust it will not be thought foreign to the present subject, to mention, that where double ditches are made in the immediate vicinity of high grounds, or on the sides of highways, care should be taken to prevent the water from the furrows, or side drains, from running into the main ditch at right angles: where this is neglected, much trouble and inconvenience arises; as when the water comes from the height, during heavy rains, in a straight line into the ditch, it presses with accumulated force against the sides of it; and if the soil is of a loose incoherent nature, the bank will be undermined, and washed away in many places. To prevent this, nothing more is requisite than to alter the direction of the furrows, or small side ditches, a few yards from their opening into the main ditch; and in place of permitting the water to fall upon the bank in a straight line, to give the furrows, or side ditches, a gentle curve; by that means, instead of falling into the ditch in a straight line, and acting against the bank in the manner we have described, the furrows will empty themselves into it, in an oblique direction; and by joining immediately with the stream in the ditch, will be prevented from having any bad effect upon the bank.

It is obvious that the water, by thus having its direction changed, can do no harm

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to the sides of the main ditch; and what is of advantage, the earth and sediment brought along with it from the high ground, instead of being deposited in that place, where the cuts enter the main ditch, which seldom fails to be the case, where the water falls into it in a straight direction, is carried off along with it; and though this sediment ultimately falls to the bottom of the ditch, yet, as it falls down gradually in its course, it is equally divided over the whole, and occasions no obstruction in any particular part.

3. *Bank of Earth, with a perpendicular Facing of Sod, and a Slope behind.*—This fence is representedin Pl. I. fig. 3, which shews the section of a high-road with a bank on each side, with a perpendicular facing of turf. It is very common, and is in some situations extremely useful; in making folds, for instance, for the confinement of sheep or cattle; it is also valuable on the sides of highways, for defending the adjoining fields, and for laying off clumps or belts of planting, in the middle or corners of arable fields, for inclosing stack-yards, cottages, gardens, &c.

The front of the bank is made with the sod pared off from the surface of the sloping ditch, and the mound at the back with the earth taken out of it. In all cases where this fence is used, the perpendicular front should be made on the outside, and the bank, on the inside of the field. But when it is employed for folds, the front should be on the inside of the fold; as in that way, it will not only present a much more formidable appearance to the sheep or cattle, but the depth of the ditch will be an addition to the height of the bank; and the earth taken out of it being laid behind, will serve as a kind of buttress to support the facing of sod, and give it a degree of firmness and durability, far superior to that of the common *turf walls*, or *fold dikes*, as they are generally termed in North Britain.

When this fence is properly constructed, a work at which the labourers are now pretty expert, it lasts a considerable time; but in its most perfect state, it is only to be considered as a temporary expedient; for however neat it may appear, or however well it may answer the purpose at first, it ultimately loses its value. In speaking of compound fences, notice will be taken of the cases in which this may be introduced with propriety, as making a part of any of them. Where wood for paling is scarce, or cannot be had, and where other materials for the shelter or protection of young hedges are equally scanty, this may be used with advantage for a time, and will both shelter the young hedge, and inclose the field; but where permanent plans of inclosing are intended, it should never be had recourse to, as however cheap it may be in the first instance, its value is transitory.

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4. *Ha-ha, or sunk Fence.* (Pl. I. fig. 4.)—The sunk fence is calculated chiefly for fields that require no shelter, and where a uniform unbroken prospect is an object, as is the case in *gardens*, and *extensive lawns*; but in all situations where shelter is wanted, the sunk fence ought to be avoided, unless a hedge is planted upon the top of it.

The form of the sunk fence very nearly resembles the mound of earth, with the perpendicular facing of turf, just now described; with this difference, that the facing of the former is stone, and the height of the fence depends entirely, or in a great measure, upon the depth of the ditch. These sunk fences are either faced with *dry stone*, or stone and lime, and are of various heights, according to the ideas of the proprietor, or the circumstances of the case. In the Report drawn up on the Northern districts, page 27, of the account of Cromarty, the following description of the sunk fence is given, which we beg leave to transcribe.—" Upon the line where this fence is intended, " begin to sink your ditch, taking the earth from as far as eight feet outward, and " throwing it up on the inside of the line. This ditch and bank is not made quite per- " pendicular, but inclining inwards towards the field as it rises; to this is built a facing " of dry stone, four feet and a half in height, one foot and three quarters broad at " bottom, and one foot at top, over which a coping of turf is laid: the ditch, or sunk " part, forms an excellent drain. The whole of this is performed, when the stones (we " shall suppose) can be procured at a quarter of a mile's distance, for *6d.* per yard."

Advantages of Ditches.—It has already been observed, that none of the different kinds of ditches, taken by themselves, are to be considered as good fences, with the single exception of the sunk fence, which we are under the necessity of classing along with them. This last answers the double purposes of an open drain, and *a fence*. But though ditches in their simple state are thus defective as fences, their use is attended with many advantages, not only in draining the field, but in affording a supply of earth; which under proper management may be converted into excellent manure. Where the soil in which ditches are made is deep, and of a good quality, the earth taken out of them, if it is either made into a compost with lime, or dung, or even spread by itself upon the adjoining fields, will greatly increase their fertility, and prove a lasting and valuable improvement: even where the soil is moss or clay, it may be converted to the same valuable purpose by burning; moss being burnt, and the ashes used as a manure, in many parts of the kingdom, and clay also. In the marshes of Somerset, the clay taken out of the ditches and burnt, is found, upon strong tenacious soils, to be highly valuable, as it breaks their cohesion, and by that means renders them not only

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less retentive of moisture, and of course easier cultivated; but also much more favourable to the growth of plants, by affording room for the roots to extend, and stretch themselves out in search of food.—Their value, as making a part of any of the compound fences, will be seen when we come to speak of that class, under the articles ditch and hedge, &c.

5. *Palings or Timber Fences. Of Palings in general.*—In all permanent plans of inclosure, palings are only to be considered in a secondary light; for of whatever wood they are made, however substantially they may be executed, or in whatever situation they are placed, their decay commences the instant they are erected. The slightest attention will be sufficient to convince every person of observation, of this truth. Where permanent use therefore is required, palings ought never to be adopted; but for ornament in pleasure grounds, or for the protection of young thorns, they are highly valuable. When the different kinds of paling come to be spoken of, notice will be taken of the mode of constructing each; but as there are certain circumstances, which may be considered as common to all palings, this is judged the most proper place to mention them.

In all cases, where either dead hedges or palings are used, the decay and ultimate loss of the fence, is owing to that part of it, which is let into the ground, being rotted by the moisture.

Where dead hedges are planted, it is no easy matter to provide a remedy against this evil; as the stems are so numerous, that, to give each of them a preparation that would completely defend it from the effects of moisture, would be attended with an expence equal to, if not greater than the value of the fence.

Where palings, however, are used, especially the most expensive and substantial kind of them, and such as are meant both for duration and ornament, it is desirable to prepare the standards, or upright parts that are placed in the earth, in such a manner as will enable them to resist the moisture for many years.*

It has been a practice time immemorial to *burn*, or *char*, that part of the standards of palings intended to be driven into the earth: the reason assigned for this practice was, that the fire hardened the parts thus subjected to it; and by rendering them

* In the South of England, the post is always more bulky at the lower end than the upper, and is fixed in the ground by digging a hole, placing it therein, shovelling the soil in, and ramming it round the post till it be firmly fixed.

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impervious to moisture, made them more durable than they would have been without such operation.

But the best defence at present known against the effects of the weather, is the bark of the tree. This covering it has from nature; and it is possessed of every requisite that is necessary, being impregnated with oil, resin, and other matters, which secure it completely, not only against moisture, but other injuries arising from the operation of *air*, light, heat, &c.; of this we have strong proofs, by observing what happens where the bark of any tree is destroyed, by cutting off a branch, or otherwise. If the surface laid bare by the wound is considerable, the body of the tree opposite to it begins immediately to decay, and continues to waste, unless some covering is made use of to supply the place of the bark; for that purpose, nothing has yet been found so effectual as a coat either of boiled oil, or of oil paint; which, by completely excluding both air and moisture, not only preserves the tree from rotting, but also prevents it from bleeding, and wasting itself, by an effusion of juices from the wound.

When trees are cut down and sawn into planks, whether for palings, or any other purpose, where they are afterwards to be exposed to the weather, the same thing happens, that we have mentioned as taking place with the growing tree, when deprived of its bark, but in a much greater degree; as the whole surface is then without a covering. To prevent this decay, the same remedy should be applied, *viz.* painting the whole of the wood, or otherwise filling the pores with oil, in such a manner as to prevent the entrance of moisture. There are now coarse oil paints sold of all colours, so cheap as to enable persons erecting palings, or other works of wood, to paint them at a small expence: another very good remedy is to be had at a moderate price (Lord Dundonald's coal varnish), into which if the points of the standards that are to be drove into the earth, are dipped while the varnish is boiling hot, it will preserve them from the bad effects of moisture for a very long time; previous to the dipping, they should be properly sharpened, and upon no account whatever charred or burnt, as every attempt of that kind will, upon inquiry, be found to injure the texture of the wood, and hasten its decay. This application, which has been found highly valuable for many purposes, and for which the noble discoverer is entitled to the gratitude of his country, has only one fault namely, that it does not penetrate deep into the wood; and after being laid on a few months, is very apt to scale, and throw off with frost, or the action of the sun; it has the farther disadvantage of hurting the appearance of the wood, and giving it an *old*, *black*, decayed look. Common tar, or melted pitch, may also be successfully

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employed for the purpose of defending the extremities of the upright parts of paling from moisture; linseed, and train oils may also be used with success; the great object being to fill the pores completely with some unctuous or greasy matter, so as to prevent the admission of moisture.

The posts should be completely dry, before they are dipped in any of these preparations; for if they are either made of green wood, or have imbibed much moisture; if, after being dipped they are exposed either to the heat of the sun, or a severe frost, the moisture will become so much expanded thereby, as to burst through, and bring off the coat of paint and varnish &c.; whereas, when they are made of well seasoned wood, and are at the same time perfectly dry, and the *pitch*, *oil*, *varnish*, &c. boiling hot, it readily enters the pores, and by filling them completely, prevents the access of moisture.

In a few instances, a method different from any of these has been tried, and found in some degree to answer; instead of sharpening the points of the standards, they are left of the same thickness at both ends, and the extremities, instead of being drove into the earth, in the ordinary way, are let into large stones sunk into the earth, with round or square holes cut into them, of such a size as to admit the square ends of the posts. In that way, the upright posts of palings certainly last longer than when they are drove into the earth without any preparation; but the difference of durability in the two cases bears no kind of proportion to the difference of expence; and as these stones are sunk into the earth, and of course within the reach of the moisture, the decay of the paling, though somewhat protracted thereby, is in the end equally certain.

Upon the whole, when the expence and durability of these different methods are compared, it will be found by much the best way to drive the standards into the earth, after having previously prepared them by dipping the extremities into any of the articles we have mentioned; and of which we think any of the coarse oils by far the best. In addition to which we have to add, that this dipping and preparation should be so applied, as to rise several inches above the surface of the earth after the standard is drove in; for if no more is dipped than what is drove into the ground, the wood will imbibe the moisture at the surface, and very soon rot and decay at that place.

Thus much of the preparation of that part of the wood which is drove into the earth. To render the whole paling as durable as possible, it should receive a covering, either of Lord Dundonald's varnish, or one of the coarser kinds of oil paint, or oil. Where use only is wanted, and the appearance of the paling is not an object, a coat of varnish or oil will answer very well; but when a paling is made of dressed wood, substantially

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excuted, and no sight of the road, or of a gentleman's house, it becomes necessary to unite use with ornament. In such cases a coat of white, or green oil paint, will defend the wood equally well, and look much better: where it is intended that the paling should appear visible at any great distance, and convey an idea of inclosure, the white paint should be used; but when it is meant to conceal the fence, and give an unbroken view of extensive lawns or pleasure grounds, the green paling is preferable; next to the ha-ha, or sunk fence, it is the best contrivance for that purpose; being of the same colour with the grass, it is not visible to the eye at any great distance.

Having thus mentioned, what appeared very essential respecting palings in general, we now proceed to notice the different kinds of these, and offer some observations on each.

1. *Simple nailed Paling, or Fence.* (Pl. I. fig. 5.)—The nailed paling consists of upright posts, drove into the earth at certain distances, and crossed in three, four, or more places, with pieces of wood in a horizontal direction. This paling is for the most part made of coarse sawn wood, without any dressing whatever; in Scotland it is termed a slab paling, and is the one commonly employed for the protection of hedges, and for strengthening ditches, &c. For temporary purposes it answers extremely well; but where durability is required, and where no other fence is used, it will be found a very frail and insufficient fence.

Jointed horizontal Paling, or Fence. (Pl. I. fig. 6.)—The jointed horizontal paling, consists of massy square poles drove into the earth at regular distances, through which mortises or openings are cut, for the reception of the extremities of the horizontal pieces which traverse them. When properly executed, this fence has a neat and durable appearance. It is, however, much less so than it appears to be, as the points of the piles drove into the earth soon rot, and the mortises, or openings cut in the body of the piles, for the reception of the horizontal pieces, weakens them very considerably, so much so indeed, that in very many instances, the paling fails fast at those places where the joinings or mortises are made. Where valuable palings of this kind are made, there is an esay method of fastening the horizontal to the upright parts of the paling, without cutting or weakening any part of the upright posts. This consists in fastening the cross, or horizontal bars, to the upright posts with iron staples. These, while they answer every purpose that can be expected, from binding and connecting the different parts of the fence, have not the smallest tendency to diminish the strength, or acclerate the decay of any part of it.

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3. *Upright Lath Paling.* (Pl. I. fig. 7.)—The upright lath paling, is made by driving a number of strong piles into the earth at regular distances, and crossing these at top and bottom with horizontal pieces of equal strength; upon these last are nailed, at from six to twelve inches distance, a number of square pieces of sawn wood, of the shape and size of the laths, that are used for the roofs of tiled houses.

This paling when properly executed looks very well, and notwithstanding its apparent slightness, if it is well supported by props or rests at regular intervals, lasts a long time.

Where there are plantations of young firs in the neighbourhood, laths may be had at a trifling expence; and for the protection of young hedges, &c. this will be found superior to almost every other, as the closeness of the upright pieces will prevent the sheep or cattle from putting through their heads between them, and cropping the young hedge, an advantage which horizontal palings do not possess.

For gardens it will be found both useful and ornamental, and infinitely better adapted to the training of fruit trees and currants, than the common espalier rails.

4. *Horizontal Paling of young Firs, or the weedings of other young Trees.* (Pl. I. fig. 8.)—Upon estates where there are extensive woods, or where they are surrounded by belts of thriving planting, the thinnings of these woods or belts, will be highly valuable for making palings, especially when the plantation consists chiefly of firs: the palings of young firs are of two kinds, *viz.* horizontal and upright. The horizontal resembles the jointed dressed paling described, fig. 6, the upright is similar to the lath paling. In the sketch that is given, the young firs of which fig. 8. and 9. are formed, have their lateral branches cut off at about three inches distance from the trunk. This has several advantages, *viz.* that of rendering them stronger than they can possibly be, when the lateral branches are cut close by the trunk; the labour required to prune them is also less, and they make a better fence than such as are close trimmed, as the sharp projecting points prevent the sheep or cattle from leaning or rubbing upon them.

The upright palings of young firs, (Pl. II. fig. 9.) in place of being made in the manner above described, and as represented in the sketch, are sometimes made by driving the upright parts into the earth, and covering them at the top with a piece of flat sawn wood, through which holes have been previously bored, with a large auger, to admit the sharpened points of the upright piles: this forms a very neat paling, and when well secured with rests at the back, lasts a very considerable time.

6. *Chain horizontal Fence.* (Pl. II. fig. 10.)—The chain fence is made by fixing a

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number of strong square piles into the earth at regular distances, in the direction in which the fence is to run; each of these piles has three strong staples or iron hooks, drove into it on each side, one near the top, one within 18 inches of the bottom, and one in the middle; to these staples or hooks, chains are fastened and stretched horizontally, in the same manner as the pieces of wood are in a common horizontal wooden fence. When it is meant, that the fence may be laid open for any temporary purpose, hooks are drove into the posts in place of staples, and the chains hung upon them; but where this is not wanted, the staples will be found the most secure.

In some cases the upright part of this fence, in place of wooden piles, such as we have described, consists of neat pillars of mason-work, with hooks or staples batted into them, for fastening the chains to; these when properly executed look extremely well, and last much longer than the wooden posts.* For the confinement of horses or cattle, a chain fence will answer very well, and if the pillars are of stone, will be very durable; but will be found totally unfit for inclosures, where sheep, hogs, &c. are meant to be pastured; it is besides so very expensive, that it never can come into general use. In avenues, however, (Pl. II. fig. 11.) and public walks, and for stretching across rivers, and pieces of water where there are no floodgates, and where no other fence can be made to complete the inclosure, they will be found preferable to every other contrivance.

7. *Net Fence.* (Pl. II. fig. 12.)—The net fence is chiefly used in shrubberies and pleasure grounds, and consists, like fig. 10. of a number of square piles of wood drove into the earth at regular distances, each of which has a couple of holes bored through it, one at top, and another at bottom, large enough to admit a rope about twice the size of a man's finger; these ropes, after being drawn through the holes, are stretched the whole length of the fence, and well secured, and upon them a strong net is fastened, of a length and breadth suited to the fence, either by sewing, or tying it at regular distances with strong cord or rope yarn, at top and bottom; it is farther secured below, by one or more wooden hooks drove into the earth between each of the piles; this completes the fence; to render it durable, not only the piles, but also the net and ropes, should be covered with a coat or two of good oil paint. When well finished, this fence

* In a few instances the purpose of posts is answered very completely by large growing trees, into which hooks or staples are drove for fastening the chains, as in gentlemen's avenues, public, walks, &c.

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has a very pretty appearance, but is neither a durable nor useful one, as sheep and cattle readily tear and destroy it with their horns, and in many instances, the sheep get themselves so much entangled, that in struggling to disengage themselves they are either much hurt, or entirely strangled. In point of utility, the net fence has nothing to recommend it; but as it will in many instances give a neat finished look to pleasure grounds, we have given it a place here.

8. *Rope Fence.* (Pl. II. fig. 13.)—The rope fence is nearly the same as the former, that is, it consists of upright posts, drove into the earth at regular distances, with holes bored through them for the ropes to pass; in general, they consist of three, and in some cases of four courses of ropes, like the chain fence. This can only be used for confining cattle or horses; for sheep, they will be found quite incompetent; for stretching across rivers, or pieces of water, as has been noticed when speaking of the chain fence, the ropes will be useful, or even for adding to the height of a stone, or turf wall, especially the latter, into which if posts are drove at certain distances, and one course of ropes put through them, such an addition will render a very insufficient fence, secure and valuable.

One observation seems necessary upon the subject of this fence, namely, that the perforating of the posts for passing the ropes through weakens them considerably; notice has already been taken of a similar mischief, in the jointed horizontal paling, or posts and rails framed, and a remedy pointed out, *viz.* that of fixing the cross bars, or horizontal pieces to the upright parts by staples. In the rope fence this may be resorted to with equal advantage, as staples or ring-bolts drove into the wood, answer every purpose, without impairing in the smallest degree the strength of the posts.

9. *Moveable wooden Fence, Flake, or Hurdle.* (Pl. II. fig. 14.)—The stake, or hurdle fence has hitherto been principally employed in cases where sheep or cattle are fed with turnips in the field, to divide a certain portion of their food at a time; in that way they are extremely useful, as the sheep or cattle, by having a given quantity of food allotted them at once, eat it clean up without any loss, which they would not do if allowed to range at large over the whole field. There are, however, many other purposes to which flakes may be applied with equal advantage. In the grazing of a large field, for instance, when the sheep or cattle are turned upon it early in the spring, they tread down and destroy a great deal of the grass, and by dropping their dung and urine upon the remainder, injure it so much as to render it unpalatable to the stock: in that way a great proportion of the grass is lost in every field of any considerable extent:

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whereas, when the stock is first put upon the field, if a flake fence were run across a small part of it, as is the case with turnips, and the grazing stock kept there till they had eaten the herbage clean up, they would then, from necessity, eat a great deal that is entirely lost when they are permitted to range over the whole field. In that way considerably more stock might be fed upon a given space than is done at present. It is to be observed, however, that the first space divided off by the flakes should be next the water, especially if the field is grazed by black cattle or horses, and that progressively; as the stock removed from the watering-place, a lane should be left by which the cattle could travel to the pond.

It is also to be noticed that, after the first space allowed to the grazing stock is eaten clean up, as soon as they are shifted to a new place, a course of flakes shou'd be placed behind them, to prevent them from going backward upon the pasture that has already been eaten bare; by this management the whole of the herbage, upon every space allotted to the stock, will not only be completely eaten up, but by dividing or fencing off that part which has been eaten, the plants are allowed to recover, and long before the whole field is gone over, the space first eaten will be in a situation to receive the stock a second time. By this method the dung and urine of the stock, instead of rendering the herbage nauseous and unpalatable, and thereby preventing them from eating it, will by its fertilizing powers assist its growth, and render it sooner fit for being eaten a second time, and by that means afford three or four crops in the space of a year instead of one. Experience has sufficiently evinced the great profit and advantage that attends the practice of teddering cattle or horses upon good pasture, or of feeding them in the house with cut grass; the benefit in both these cases arises from the whole of the herbage being completely eaten up, without any part of it being lost. The same benefit, but with infinitely less trouble, may be reapt from *flaking* grass fields; every possible advantage will be made of them in that way; and in very many instances it will happen, that before a half or two-thirds of the field are gone over by flaking, the part first eaten, will be in a situation again to receive the stock: by that means a part of the field may be saved for hay, or if the views of the occupier are of another kind, the number of the grazing stock may be increased.

It may, and no doubt will be argued by many, that this management will be attended with much trouble and expence; and after all that the profit resulting therefrom will be but small, and scarce prove an equivalent for the trouble and extra-expence. From the acknowledged value of flaking, however, in the consumption of

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turnips, *cabbages*, &c. and the great profit which arises from giving the stock, only a certain quantity of food at once, and withholding any more from them till that is eaten up; some idea may be formed of the vast advantage that would attend the flaking of a grass stock.

We by no means, however, wish these observations to be understood as applying to grass pastures of every description, quite the contrary; as there are many situations where the expence and trouble of flaking, would prove more than an equivalent for any advantage that could be reaped therefrom.

We have only to add, that upon all rich pastures, the benefit arising from the practice of flaking, will be found very considerable, and a single experiment will be sufficient to convince the most incredulous.

10. *Osier or Willow Fence, or wattled Fence.* (Pl. II. fig. 15.)—This fence is made by driving a number of piles, of any of the different kinds of willow or poplar, about half the thickness of a man's wrist, into the earth, in the direction of the fence, and at the distance of about 18 inches from each other. They are then twisted, or bound together at the different places, with small twigs of the willows or poplars, as represented in the sketch. This kind of fence has some advantages peculiar to itself; it not only forms a cheap and neat paling, but if it is done either about the end of autumn, or early in the spring, with willows or poplars that have been recently cut down, the upright parts or stakes will take root, grow, and send out a number of lateral branches; and if pains are taken the following autumn, to twist and interweave these branches properly, a permanent fence, so close as to be almost impenetrable, may be formed in two or three years. For the inclosing of marshy lands, or for completing any inclosure, where a part of the line in which the fence ought to run is so wet as to be unfit for the growth of thorns, or the building of a wall, the willow paling will be found an excellent contrivance, and the use of it will render many inclosures complete, that would otherwise be faulty.

11. *Paling of growing Trees, or rails nailed to growing Posts.* (Pl. II. fig. 16.) This paling is made by planting beach, larch, or other trees in the direction of the fence, at about a yard distant from each other, more or less as may be thought necessary; these trees should be protected by a common dead paling, till they are ten or twelve feet high, when they should be cut down to six feet, and warped or bound together with willows at top, and in the middle; the cutting off the tops will have the effect of making them push out a great number of lateral branches, which, if properly warped

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and interwoven with the upright part of the trees, in the manner described for the willow fence, will both have a beautiful effect, and will at the same time form a fine fence, which in place of decaying, will grow stronger with time, and may with very little trouble be kept in perfect repair for ages.

12, and 13. *Horizontal, and upright Shingle Fences.* (Pl. III. fig. 17, and 18.)—The shingle fence is chiefly made of firs, coarsely sawn into deals, of from half an inch to an inch thick, and of different breadths according to the diameter of the tree; pretty strong square piles are drove into the earth, and the deals nailed horizontally upon them, in such a manner that the under edge of the uppermost deal shall project or lap over the upper edge of the one immediately below it; the fence, when finished in this manner, will have nearly the same appearance as the bottom of a boat or cutter. This description will be well understood by those who have been in North America, where not only the roofs, but the walls of many of their houses are made with shingles. When completed, this fence is nearly as formidable as a stone wall, though, as may naturally be supposed, it is much less durable.

An upright fence is sometimes made with shingles, which when properly excuted looks extremely well, and is indeed highly ornamental; this fence is made by fixing perpendicular posts in the earth, nailing three pieces of wood horizontally, and covering these with shingles placed perpendicularly; in this case the shingles are not above three inches broad, and the extremities of each are pointed at the top. Several fences of this kind are to be seen upon the road from Edinburgh to Glasgow, especially upon the property of Sir W. Cunningham of Livingstone, Walter Campbel, Esq. of Shawfield, and some others. These upright shingle fences are painted white, and have a very handsome appearance.

It is seldom that inclosures of any considerable extent have been made with these shingle fences; for folds they answer extremely well, and can be shifted with as much ease as flakes from one field to another; they are also useful for temporary purposes in gardens, &c.; and where turnips are eaten with sheep upon the field, these shingle fences will be found preferable to the common open flakes, from the shelter they afford to the sheep.

14. *Warped Paling.* (Pl. III. fig. 19.)—This paling consists of pieces of wood drove into the earth, bent down in different directions, and their tops fastened together, as in the sketch; this fence resembles the chevaux de-frise, with this only difference, that in place of leaving the points standing up, as is the case with that part of fortification,

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they are bent down and tied together. When made of dead wood, this fence is equally perishable with others of the same description; but when made of growing plants, it will be found a very valuable one.

15. *Light open Fence with Thorns, or the Branches of Trees wove in.* (Pl. III. fig. 20.)— This paling differs from the common nailed fence already described, only in being warped either with thorns, or the branches of trees. When properly done, it forms at once a very complete fence; but like all fences made with dead wood, it will be found very perishable, and require many repairs. It has, however, one advantage, *viz.* that when properly executed, it is proof against the entrance of any animal whatsoever.

Dead Hedges. (Pl. III. fig. 21, &c.)—Dead hedges are made with the prunings of trees, or the tops of old thorn or beach hedges that have been cut down, and are principally intended for temporary purposes, such as the protection of young hedges, till they have acquired a sufficient degree of strength to render them fencible without any other assistance; for this purpose the dead hedge is well adapted, and lasts so long as to enable the live fence to grow up and complete the inclosure. In many cases, however, dead hedges are had recourse to as the sole fence, and where there is no intention of planting quicks, or any other hedge. From their very perishable nature, however, they are found to be exceedingly expensive, so much so indeed, that after the first or second year, they cannot be kept in repair at a less expence, than from a fifth to a tenth part of the value of the land, and sometimes more.

When dead hedges are meant for the protection of young live fences, if the quick fence is planted upon the common surface, the dead hedge is made in a trench or furrow immediately behind it, in such a way as to prevent the sheep or cattle grazing in the inclosed field from injuring it; where the quick fence, however, is planted upon the side of a ditch, the dead hedge is for the most part made on the top of the mound, formed by the earth taken out of the ditch; these are called plain dead hedges, being made by cutting the thorns, or brush-wood of which they consist into certain lengths, and putting them into the earth. We call them plain, in opposition to other descriptions of dead hedges where more art is used, such as the dead hedge with upright stakes wattled, and the common plaited dead hedge, bound together at the top with willows; of which the reader will be able to form a much better idea, that can well be conveyed by words, by observing the sketches.

Fig. 21. Represents a dead hedge inclining a little, placed upon the plain surface in the ordinary way.

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Fig. 22. represents the common dead hedge, which is almost the only fence in several of the English counties, with the thorns, or dead wood let into the earth about twelve or fourteen inches, and fastened at the top with willows or hazels.

Fig. 23. wattled dead hedge, with strong upright posts, or what is generally termed stack and rise, or in Scotland, *stake and rue.*

This last, and the one immediately preceding it, form very handsome fences; it is only to be regretted that they are not permanent ones, seldom lasting above a year or two: this defect is complained of in many of the Reports, particularly that of Lincolnshire: the words of Mr. Stone the surveyor are, page 34, " Dead fencing supplies the " place of live, which occasions an eternal expence to the occupier, 1st. in purchasing " the fencing stuff, and bringing it from a considerable distance; and 2dly, in the delay " of his interest, by reason that the land occupied by a dead fence, might sustain a live " one, which would not only answer the present purpose; but in place of decaying, " would be annually improving."

The truth of this observation cannot be disputed, as the soil and climate, in almost every situation where these dead hedges are complained of, are such that hedges of live plants would not only grow, but could be made at equal, perhaps less expence than these temporary erections, and with this advantage, that in place of decaying, and occasioning an endless loss and expence for repairs, they would be every year growing stronger, would require little expence to support them; and in place of the forlorn decayed appearance which dead hedges never fail to give a country, they would at once shelter and ornament it.

It cannot therefore be too strongly recommended to proprietors and farmers, in those parts where dead hedges are at present so much used, and so justly complained of, to substitute live hedges in their place; the expence of doing so will be trifling, and the benefit arising therefrom immense. In carrying a plan of this kind into execution, there is no occasion to throw such fields as are at present inclosed with these temporary fences open, quite the contrary, the dead fences ought to be preserved, till the young plants have attained such a strength, and size, as to enable them to form a good fence, without any auxiliary aid: in that way, the inclosure will not only be preserved, but the dead fence, from the shelter it will afford to the young plants will accelerate their growth, and render them much sooner useful, than they would otherwise be. This change of system would be at once pleasant and profitable to all concerned, the expence of inclosing, which is at present severely felt, would be done away, the

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appearance of the country considerably improved, and the public benefited in a great degree: and as no doubts can be stated as to the practicability of this scheme, we trust that the bare mention of it, will be sufficient to dictate a better system of inclosing to those concerned. The idea entertained by some landlords, that, provided a farm is once let, with the usual burden upon the tenant of supporting the fences, the nature of the fence is of no importance to them, deserves the strongest and most pointed reprobation; indeed, it could scarcely be supposed, that men who have a *permanent interest* in the property would reason in this manner. There can be no doubt, if lands are let to a good tenant, for a term of years, that the landlord is certain of drawing his rent during the currency of the lease, whatever the expence of supporting the fences may be: but if this tenant is a man of sense, the offer he makes will proceed upon the value he has in his own mind, formed of the nature of the soil, and the expence which must unavoidably arise from cultivating and sheltering it, and bringing the produce to market: the farmer who has not made, or is not capable of making such a calculation, can never be a desirable tenant to any proprietor; but if the tenant possesses this necessary knowledge, the yearly rent he will offer for the farm, will be less in proportion to the sum, which he expects annually to expend in constructing or supporting these fences: we trust slender observation is necessary to convince intelligent proprietors or farmers, that the substitution of live, for dead fences, will not only make the inclosures more perfect, but will make an addition to the annual value of the property, equal to, if not greater than the expence at present incurred, in keeping these dead fences in repair.

It need hardly be added, that as the greatest value of these fences consists in their completing inclosures, and sheltering the young hedges, till they arrive at a certain age, they should never be thought of, by either proprietors or farmers, except for these or other temporary purposes.

Of Live Hedges.—Live hedges are made either entirely with one kind of plants, or a mixture of different kinds, and for that purpose almost every tree or shrub, known in Britain are either wholly or in part employed. In a subsequent part of this Paper, some account will be given of each; but as there are certain circumstances common to all of them, and upon which the success of every attempt made to rear good fences will be found ultimately to depend, this seems the proper place for mentioning them.

These circumstances are,

1st. The plants suited to the soil and climate.

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2d. The preparation of the soil.

3d. The time and mode of planting.

4th. The age of the plants.

5th. The size of ditto.

6th. The dressing, or pruning of the tops and roots before planting.

7th. Weeding, and hoeing ditto.

8th. Pruning, and after management.

9th. Filling up gaps in hedges.

10th. Diseases to which hedge plants are liable, and the remedy.

1st. *Plants suited to the Soil, Climate, &c.*—Upon the proper choice of plants suited to the soil and climate, where the hedge is to be made, the success of every attempt to inclose with live fences will be found to depend.—A mind given to observations, and capable of applying these observations to useful purposes, will receive considerable assistance upon this point by attending carefully to the indigenous trees, or shrubs which thrive best, and attain the greatest size upon particular soils, and in certain climates: by an attention of this sort, many plants, which are seemingly of small value at present, might be rendered highly useful by planting hedges with them.

But though an observation of this kind will in some instances serve as a guide, and lead the person who makes it to certain useful practices, it is not always to be depended upon, as there are many situations where neither trees nor shrubs, fit for making hedges, are to be met with in an indigenous state, and even when they are met with, their nature will not admit of their being transplanted.

Fortunately in these cases, though nature affords no guide to assist us in the choice of the plants, we will find sufficient direction from the experience of the country, by carefully noting the circumstances of soil and climate, under which certain plants that have been introduced into them have prospered, and either risen into trees, or made good fences. In the observations prefixed to this Paper, notice has been taken of the great loss which attends the fence, and the plants of which it consists, not being properly adapted to the natural circumstances of the soil they are meant to inclose; many mistakes of this kind might be enumerated, especially in the more elevated situations, where great labour and expence have been employed to raise hedges of hawthorn, which after many years care and attention, were found totally unfit for

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these inclement regions. In such situations, experience has now sufficiently proved that good fences can be reared in a short time, with beach, birch, larch, and the Huntingdon willow; hedges of these, ought therefore to be the only ones used in hilly countries, or upon cold wet soils; the three first upon the dry soils, and the last, with the addition of poplars, upon such as are wet or marshy.—In the low country, however, and in the less elevated parts of the uplands, the white thorn will be found the best upon all the dry, or moderately dry parts of the soil, especially the different kinds of loamy, sandy, or gravelly lands; upon clays, or cold wet soils, however, beach, crab, birch, poplar, willow, and alder may be used with advantage. The birch, poplar, alder, and Huntingdon willow, are peculiarly calculated for the coldest, wettest, and most marshy parts; while beach, crab, &c. will be found to answer best upon the stiff clays.

Hazel, sweet-briar, rowan tree, and indeed all the different kinds of forest trees, that are at present known to delight in dry soils, may also be employed for making hedges in the low lands with success; but which ever of these is used, they should if possible be without mixture. In the preliminary observations formerly referred to, notice is taken of the motley appearance, and small value of many hedges in England, made with these mixed plants: it is seldom indeed that any soil, however good, will be found equally favourable to the growth of plants, so very opposite in their nature; this circumstance alone will render their growth unequal, and of course make the fence faulty and defective; these defects in the fence, and inequalities in the growth of the plants, will increase with time, become every day more apparent, and be every day more sensibly felt; as the plants, that have thus acquired the ascendancy, will continue to keep it, and not only shade the weaker ones, and prevent them from enjoing the influence of the sun and air, but also deprive them of nourishment. Independent of these considerations, there is another of equal, perhaps greater moment, that requires to be mentioned; allowing the soil to be equally favourable to the growth of the whole plants, of which the mixture consists, there are certain plants which are highly inimical to the growth of others, when planted in their immediate vicinity; ivy and honeysuckle, for instance, when mixed with thorns, or other plants in a hedge, never fail to destroy such of the hedge plants as they fasten upon: indeed moss, which is known to be one of the worst enemies to all hedges, is not more dangerous or more certainly ruinous; even the different kinds of sweet-briar, brambles, &c. have the same effect, and in the end never fail to produce a gap in that part of the hedge where they grow, by corroding and smothering the thorns.

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2d. *Preparation of the Soil for Hedges.*—The preparation of the soil for hedges, and even plantations, though at present shamefully neglected, is nevertheless one of those points intimately connected with, indeed essential to their success; except in a very few instances, however poor the soil may be, or however strong the cohesion of its parts, no attempt is made either to break that cohesion by tillage, or improve its quality by enriching or alterative manures. The young plants being for the most part laid upon the old surface, which has perhaps never been opened by the labour of man, and their roots covered with the earth taken out of the ditch, consisting very often, of the poorest and coldest *till*, or of earths loaded with iron, or other metallic inpregnations.

To those who have considered the matter with the smallest attention, the fate of such a hedge will not appear doubtful; the surface upon which the plants are laid, will be so hard and impervious to the roots, as to preclude the possibility of their penetrating it; of course their only chance of either extending themselves, or procuring nourishment, is by spreading out between the surface, and the mound made by the earth taken out of the ditch, or by striking up into the mound, where, though the soil will be sufficiently open, to admit of this, the roots, in place finding an establishment in a situation friendly to their growth, will very often be either starved or poisoned.

In the culture of the grain, and the whole of our most useful and valuable vegetables, proper preparation of the soil by tillage and manures is deemed indispensably necessary; and experience has sufficiently evinced, that upon the perfection of the tillage, and the quality and judicious application of the manures, the success of the farmer, or gardener, and the value of their crops, entirely depend.

Is it not strange, that the same farmer who is convinced of the utility, and necessity of tillage and manures for his other crops, and who would think himself for ever disgraced, were he to sow a plant, grain, or any other useful vegetable, upon an *unplougbed, dirty, unmanured* field, should, without shame or compunction, commit a hedge, which is to form the inclosure of the field, and upon which a considerable part of its future improvement is to depend, to the earth, without any one of these aids? Incredible as it may appear, this is certainly the fact, unless, as has formerly been observed in a few instances, where better sense and stronger observation have dictated a different management. It being the uniform custom in most plans of improvement, be the quality of the soil what it may, to mark off the line of the fence, dig

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the ditch, and commit the hedge plants to the earth, without any previous preparation either by tillage or manures.

Perhaps our dwelling so long upon this subject, may be thought by some a waste of words and time, and that we have been labouring to establish a principle, the truth of which few would be inclined to dispute; but as the general practice is very opposite, and few people seem to be fairly convinced of the necessity, of paying proper attention to these points, we trust that the observations thrown out, will not be thought useless or irrelevant: what remains is merely to point out the proper way of preparing the soil for the reception of a hedge, in such a manner as to render it useful as soon as possible.

In every instance where a hedge is to be made, the ground should be previously prepared by a complete summer fallow, in order to destroy the weeds; when this is accomplished, a certain proportion of *dung*, *lime*, or *compost*, should be laid on the tract upon which the hedge is meant to be planted; after this is done, and the manure properly incorporated with the soil, a furrow should be drawn with a common plough about the end of November; in this furrow the plants should be placed, and the earth thus impregnated with the dung, or compost, drawn up to, and trod firmly about their roots. When the soil has been previously cleared of weeds in this manner, and a sufficient quantity of manure bestowed, the hedge, if the plants are healthy, and suited to the soil and climate, may be committed to the earth, with every prospect of succes.

3d. *Time and Mode of Planting.*—Of whatever plants the hedge is made, they ought always to be put into the ground, either before winter, or very early in the spring before any vegetation takes place. In that way, if the plants have been carefully taken out of the nursery ground, and no material injury done to their roots by laceration, pruning, or otherwise, their growth receives scarce any check, and they make more progress in one year, than they would do in three or four years, under different management. The beginning of November, or any time during the month of January, seems the most proper time for planting thorns.

The mode of planting differs in different places, and even in the same place, according to the nature of the hedge; when hedges are made in the face of a *ditch*, *bank*, *mound*, or *wall*, the universal practice is to lay the plants horizontally, either upon the surface, or upon a paring of sod or earth, taken from it; and afterwards cover

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them in such a manner, as that about seven or nine inches of their length shall be covered with the soil; and about three inches left projecting without it. In that way, sufficient room is left for the roots stretching out, and forming an establishment for the plant; while the part left projecting is so short, as not to be able to produce above two, or at the most three good shoots, which from the smallness of their number, will be vigorous and useful; whereas, if a greater length had been left without being covered, the shoots would have been much more numerous, and of course weaker.

The future value of the hedge, depending entirely on the number and strength of the first shoots the plants make; we have already hinted at the necessity of preparing the soil properly, by tillage and manures, in this mode of planting, *viz.* upon the plane surface in the face of a *ditch, bank, mound,* or *wall,* it is equally necessary as in any other, dung, lime, or compost, ought to be laid upon the tract, and pointed in with a spade; and in place of laying the earth taken out of the ditch indiscriminately upon the roots of the thorns, care ought to be taken to cover them with the best of the surface mold: by such treatment, having a well prepared, well manured, bed below, and a covering of good earth above, the roots of the plants have not only abundant room to spread, but have also plenty of nourishment; this gives them a decided advantage at their first starting, and enables them to make more progress in two or three years, than they would otherwise do in twice that time.

Hedge upon the common Surface.—The mode of planting this hedge is very simple; a furrow about eight or nine inches deep is made with a common plough, upon the tract that has been previously limed and dunged; to render the furrow as clean as possible, the plough should be drawn twice along it; one labourer then goes along the furrow with a bundle of plants under his arm, which he drops in handfuls of six or eight together at certain distances; when he has gone over, perhaps a hundred yards in this manner, he returns to the farther end, where he began to drop the plants; and taking up the first handful, begins to set them in the bottom of the furrow, not in a direction perpendicular to the horizon, but inclining a few degrees in the same direction that the fence runs. These the labourer places, leaning against the perpendicular side of the furrow, at the requisite distance from each other, say, from four to six, or eight inches; having placed the whole of them in this manner, he covers them with the earth from the other side, or that which has been turned up by the plough; when this operation is finished, he sets a foot on each side of the hedge, and beginning at one end of it, goes slowly along, treading the earth close to the roots of the plants

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the whole way; the soil is then pointed with a spade on each side, which finishes the operation: where the necessary pains have previously been taken to pulverize the soil, a single labourer will, with great ease and exactness, plant several hundred yards of thorns, or other hedge plants in one day.

Another mode consists, in one labourer receiving the plants by two or three at a time, from another who carries a bundle of them, setting them in the middle of the furrow, with the top reclining a little; and drawing a quantity of earth from each side with his foot to cover the roots: when about fifty or a hundred yards are done in this way, each labourer takes a common garden rake, and draws up a sufficient quantity of earth to each side of the plants; treading the surface with their feet as they go along, in such a manner as to bind the soil moderately, and at the same time set the plants in a straight line.

A third mode consists in harrowing the tract of the hedge, or raking it with a garden rake; then stretching a line along it, laying out a furrow with a spade, and afterwards planting the thorns, and laying the earth to them, in the manner described in the two former methods. Laying out a furrow with the spade in this manner, admits of the work being done with great neatness and accuracy; but it is attended with considerably more labour and expence, and after all, seems to possess no great superiority over planting with the plough.

In some cases the hedge is planted with the dibble; but as we shall afterwards have occasion to notice, this practice must be a bad one; for if the plants have the whole of their roots preserved, and are planted with a dibble, in place of the fibres being properly spread out, as they ought to be, they will be crammed together into a very narrow space, with their points staring upwards, or in other words, looking out of the soil, in place of dipping into it; or if by much pruning they are cut so close, as to be made fit for going easily into a dibble hole, their growth will sustain a severe check by such injudicious pruning: when hedges come afterwards to be spoke of, as making a part of any of the compound fences, the circumstances connected with the planting of each, will be more fully noticed.

Age at which Hedge Plants ought to be used.—It is very common, especially where young hedges are made with quicks, to plant them of one, two, or three years old, seldom exceeding this last age. Plants of this description, when put into the earth at a proper season of the year upon land that is well prepared, and that are afterwards carefully kept clean, and the earth soft and loose, by regular weeding

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and digging, seldom fail to make good fences; such young plants, however, are long in a state of infancy, and require great nursing, and the most complete protection to bring them to perfection, and are liable to be either much hurt, or totally destroyed by many accidents, that would produce little or no effect upon older and stronger plants.

It is the opinion of many sensible well informed people, that much time might be saved in the rearing of hedges, and the fence be much more perfect and useful, if older plants were employed for that purpose. Three years old is certainly the youngest that should be planted, and if they are even six or seven years old, so much the better: the prevailing idea that plants of that age will not thrive if transplanted, is totally unfounded; as with proper care they not only grow readily, but make excellent fences in one half of the time that younger plants usually do. With this additional advantage, that they are much less liable to be killed or injured by frost, drought, weeds, or the other causes that affect younger plants: thorns of six or seven years old, in place of being no thicker than a common straw, will be at a medium more than an inch in circumference; we leave those who are judges to determime, how far a plant of this last description will be superior to one of two years old, and how much sooner it will answer the purposes of a fence.

It is, however, very material to observe, that where plants of this age and size are used, the most complete care should be taken to preserve the roots as entire as possible. When we come afterwards to speak of the pruning that is necessary, before planting the different kinds of hedge plants, we will have occasion to observe the mistakes that are at present committed in that way, and the mischief that ensues from an improper use of the knife.

Size of Thorns or other Hedge Plants.—Having mentioned the age that seems best calculated for the plants thriving, and forming a good hedge; we think it necessary to observe, that, when the plants are once obtained, they should be separated into sorts, according to their size and apparent strength, picking out the largest first, and so on downwards. This will be attended with several very material advantages, which those who have made observations on the subject, will very readily understand; plants of the same size and strength when planted together, keep pace with each other; no one of them takes from the earth more than its own share of nourishment, of course the growth of the whole is regular and uniform; and the hedge, when arrived at a certain age, becomes a substantial efficient fence, of an equal height throughout, and free

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of any gaps: whereas, when no pains have been taken in assorting the plants, and they are planted promiscuously, great and small, strong and weak, the consequence is, that the strongest plants very soon outgrow such as are weaker, and not only overtop them, but also deprive them of that nourishment which they so much require: as the hedge advances in age the evil becomes greater; small stunted plants, and innumerable gaps appearing throughout the whole line of the fence; these are interspersed with others remarkable for their strength and luxuriance; the whole conveying to the mind not the most distant idea of utility. The worst part of it is, that, when hedges have been thus neglected in the beginning, no pains nor industry on the part of the farmer, will be sufficient to render them useful afterwards; there being nothing more difficult than that of repairing the defects of a hedge, after the third or fourth year of its growth.

This assorting of hedge plants has a farther advantage; namely, that of putting it in the power of the person who plants the hedge, to put down the large, strong, healthy plants upon the poorest part of the line of the fence, and to set such as are smaller and weaker upon the richer and more fertile parts. He has it also in his power by a more careful preparation of the soil, and bestowing a greater proportion of manure upon the spaces where the small plants are set, to give them that nourishment and assistance which they require, and which would very soon enable them to form a fence, equal to that part occupied by the strongest plants. In an after part of this Paper, more will be said upon this subject; at present it is only necessary to state, that in every case, it is desirable to have the plants of which a hedge is made, as nearly as possible of one size and strength; but as there is little probability of meeting with a sufficient number of plants of that description, to complete a hedge of any considerable extent, much advantage will arise from assorting the plants properly, and placing the strongest and most healthy, upon the weakest and worst parts of the line of fence, and the smallest and weakest in the spaces where the soil is of a better quality, and contains nourishment sufficient to raise them to an equality with the stronger and larger ones.

Dressing and Pruning of Hedge Plants before they are put into the Earth.— There is perhaps no part of the system of managing either hedge plants, or forest trees, before they are planted, more hurtful and defective than that now pursued in the common nurseries.

It is a very common practice with nurserymen in the spring, when they wish to clear their ground for other purposes, to take up great quantities of thorns and other hedge

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plants; and after pruning the tops, and cutting off nearly the whole of the roots, to tie them up in bundles, and lay these bundles in heaps till they are called for. In that mutilated state they often remain for many weeks, with the mangled roots naked and unprotected, exposed to every inclemency of the weather, before they are sold. The consequence is obvious; the severe pruning by curtailing the number of the roots, and depriving the plants of the means of drawing their nourishment from the earth, would of itself prove an effectual check to their future growth, even if they were planted immediately after this severe trimming; by being allowed to remain so long exposed to the weather, afterwards, the tender fibrous extremities of the remaining roots are most of them destroyed, and when the plants are afterwards put to use, they are not only half dead, by being so long above ground, but are as it were insulated, and their connection with the earth cut off by the pruning and destruction of their roots. Under these unfavourable circumstances, they must remain in the ground till new roots are produced, during which period they suffer a total want of nourishment; and if the soil is dry, and much warm dry weather follows the planting of the hedge, many of the plants will perish, before they are capable of pushing out, and producing a number of new roots sufficient for their support; accordingly, many of them fail from these causes; and numbers of hedges, which, under different management and with small trouble, would soon have been complete fences, are full of gaps, and remain for ever after in an imperfect state.

When thorns or other hedge plants are thus severely handled, and their roots and tops so unmercifully cut off, they resemble cuttings more than plants, and must remain a very long time in the earth, before they are capable of sending out new roots, or drawing from it a quantity of nourishment adequate to their support.

Were nurserymen and others to bestow the smallest attention upon the subject, common sense would dictate a very opposite treatment. Men of observation know, that in every instance where either trees, or herbaceous plants are to be transplanted, the more carefully they are taken out of the ground, the more numerous and entire their roots, and the sooner they are again put into the earth, the less check will they receive, and the quicker and stronger will they afterwards grow. If these observations are just, how faulty and defective must the system we have just now described appear. Indeed, nothing can be more repugnant to nature and common sense, than to suppose, that when plants of any description, are removed from the situation in which they are growing, and sent to such a new establishment in a different soil,

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and perhaps a worse climate, they will thrive better by having their roots cut off, and being almost entirely bereft of the means of obtaining nourishment. With equal probability might success be expected, from planting a colony with people, after having completely mutilated them, by cutting off their hands, putting out their eyes, &c. &c.

In place of this treatment, the defects of which are so obvious, and the consequences resulting from it so hurtful; no hedge plants should be lifted out of the nursery ground, till the day on which they are to be replanted; and instead of digging them with a spade, by which they are often much injured, they should be taken up with dung forks, with strong round prongs, taking care to disengage the roots carefully from the soil; and in place of the severe pruning and dressing already mentioned, every root, even to the smallest fibre, should be carefully preserved, and the use of the knife confined entirely to the necessary curtailing of the tops. Where this care is taken, and the plants put into the ground at a proper season, they will suffer no kind of check, and when the spring arrives grow luxuriantly.

Weeding and Hoeing of Hedges, &c.—Much of the benefit arising from an attention to the foregoing circumstances, will depend upon the after management of the hedge. Complete weeding, loosening, and laying new earth to the roots, for the first three or four years, are indispensable requisites; for whatever pains may have been previously taken in dunging, and summer fallowing the soil, unless it is properly attended to, and kept clean afterwards, this dunging and summer fallow, in place of being useful, will prove hurtful to the fence; as the manure and tillage, by enriching and opening the soil, will encourage and promote the growth of weeds; which under circumstances so peculiarly fortunate, will become so luxuriant, as either to destroy or materially injure the growth of the hedge, unless they are kept down by frequent and complete cleanings. These weedings are of two kinds, and ought to be conducted in two different ways.—If the weeds are principally annuals, a slight scuffle with a hoe will be perfectly sufficient; and this to be repeated as often as a new crop of weeds appears: but when the weeds in place of annuals are composed of root weeds, or in other words, of perennial, or biennial plants, the extirpation of these last will be attended with more trouble. With weeds of this description scuffling will not answer, as though the tops may be cut off by that operation, the roots remain, and not only furnish repeated crops of the same weeds, but also rob the hedge of its proper nourishment. In place, therefore, of scuffling and cutting off the tops of such weeds

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with a hoe, the ground ought to be carefully dug with a *dung fork*, of the kind already described for lifting thorns; an instrument of this sort is preferable to a spade, as it cuts none of the roots of the hedge, loosens the ground sufficiently, and at the same time admits of the weeds being readily and easily picked out. The first weeding of this kind that is given to a young hedge should be early in the spring, when, if it is completely done, there will be little occasion for any farther trouble during the season; cleaning at that period has a farther advantage, namely, that of loosening the soil, at the exact time when the roots are beginning to spread and extend themselves. Whereas, when it is delayed till the summer, the weeds have attained a considerable size, have deprived the hedge of much nourishment, and the opening of the soil then exposes the roots of the hedge to the parching heat of a summer sun.

In the cleaning of young hedges, especially such as are situated in the face of a ditch or bank, it is the universal custom for the labourer to skim off the surface with a spade, and let it fall into the bottom of the ditch. This operation, though it gives the hedge an appearance of cleanness, is attended with some very considerable disadvantages: repeated parings of that kind in the face of a ditch or bank, in a few years waste the front so much as in some degree to undermine the hedge, which after frost or wet weather is apt to slide and tumble down; the paring off and throwing into the bottom of the ditch so much earth, together with the roots and weeds it contains, very soon chokes and fills it up.

When ditch and hedge comes to be mentioned, notice will be taken of the necessity of constructing that fence in such a way, as that the hedge shall not project immediately from the front; but shall be placed upon a shelf, or what is termed a scarcement, of not less than twelve or fourteen inches broad. By such management the hedge will run no risk whatever of being undermined, by the earth falling into the ditch, and may be kept clean with as much ease as a common garden border. The proper method of cleaning a hedge planted in this manner, seems to be, that of digging the border with a short pronged fork in the spring, picking out such of the weeds as can be readily taken up by the hand, and afterwards raking it with a garden rake; this last operation, along with its making the surface smooth, and giving the work a finished look, will also bring out a great number of the smallest roots that had escaped the labourer's notice in digging it with the fork.

Some imagine that, by a slight weeding once or twice a year, for the first two or three years after the hedge is planted, they do all that is requisite; this, however, is

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a mistake; for though a hedge may, by care and attention for the first five years of its growth, attain such a height, as will prevent it from being smothered by the weeds, still it will suffer much injury from them, not simply by the nourishment they take from the hedge, though that must be considerable, but by the effect they have upon the lateral branches near the root, many of which they kill, and by that means render the fence open and naked at the bottom. Skilful hedgers are well acquainted with this circumstance, and very properly consider annual cleanings, and loosening the soil about the roots, as equally necessary to the welfare of the hedge, as the other operations of switching, pruning, &c. &c.

The apparent trouble and expence of cleaning every description of hedges yearly, will no doubt present a formidable obstacle to the practice; but when properly considered, this labour and expence will be found more apparent than real. For if a proper weeding has been given, when the hedge was first planted, and the earth well opened, the only trouble required afterwards, will consist in giving the ground on each side of the hedge, a slight scuffle with a hoe, a work at which a labourer will be able to do a very great deal in the course of a day. To this practice of keeping hedges clean, with a view to promote their growth, is to be added another motive of equal, indeed of superior moment:—round most of the inclosed fields in Britain, the space occupied by the fence is considerable, and as no part of this space is under the plough, it is left to produce such plants as nature or accident may have brought into the soil: these, by being suffered to grow, and their seeds ripen yearly, are wafted by the wind into the adjoining fields; where they multiply beyond conception, and create an endless trouble to the occupier, rendering abortive a great part of the labour and expence incurred in fallowing. A person who is sensible of the advantage arising from the extirpation of weeds of every description, either in the fields, or their immediate vicinity, must feel a considerable degree of pain, to observe, about the end of summer, clouds of the winged, or bearded kinds rising from the side of every hedge or highway, with the slightest breeze of wind, and scattering themselves over the adjoining fields, which have been perhaps fallowed the year before, at a heavy expence: the evil is undoubtedly great, and affects the innocent as well as the guilty; it being no uncommon thing for the best farmers to have their fields rendered foul, by the wind blowing the weeds of their slothful dirty neighbours upon them. The remedy is easy; let every farmer be obliged to cut down the weeds round the whole line of his fences, so early in the season as to prevent them from running to seed; and let the trustees in

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every county, in making contracts for the repair of the public roads, bind the contractor to cut down the weeds annually. The labour of these operations will be very trifling, their benefit to the public immense.

In loosening the earth about the roots of hedges, whether old or young, it will be of advantage, if there is soil enough to admit of it, to lay up a few inches of it to the roots; doing this frequently, encourages them to push out branches near the bottom, which prevent them from growing thin and open, a fault to which almost all hedges are liable, if due pains are not taken to prevent it.

When a hedge has been planted in the face of a *ditch*, *bank*, or *mound*, with a projecting space or scarcement before it, of sufficient breadth, a supply of new earth may be laid up to the roots every two or three years, from the sediment let fall by the water in the bottom of the ditch; this sediment is in general the richest of all soils, and as it is necessary to remove it from the bottom of the ditch, for the purpose of cleaning the water-course, employing it in this way, not only saves the trouble of carrying it elsewhere, but promotes the growth of the hedge, and gives the fence a much more finished look. Upon the sides of highways, the same thing may be done with advantage not only to the hedge, but the road also: for though there may be no ditch to require cleaning, yet as most of the highways in Britain, have a greater or less declivity towards the sides, the decayed materials of which the road is made, together with the horse dung, and other matters dropt upon it, are washed down from the top to the sides, where it accumulates in considerable quantities; shovelling this carefully up, and laying it to the roots of the hedge, affords the plants at once protection and nourishment. Where hedges are planted upon the plane surface, the earth can be laid up to the roots with great ease; and at each cleaning, it certainly should be done, the trouble of doing so is trifling, the advantage considerable.

Pruning, and after Management of Hedges.—Though a strict attention to the foregoing circumstances, during the infancy of a hedge, is highly necessary to produce healthy, vigorous plants, a very considerable part of its beauty and future value will depend upon the pruning and after management that is bestowed upon it.

There is, perhaps, no part of the subject upon which a greater contrariety of opinion at present prevails, than the age at which the pruning of hedges ought to commence, the manner of that pruning, or the season of the year, at which it may be given with the greatest possible advantage, and the least risk; the practice with some is to prune from the first year, not only the lateral branches, but the tops also, and give, as a

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reason, that cutting off the extremities of the shoots contributes to the thickening of the hedge, by making them push out a great number of new ones. The fallacy of this argument, and the mischief with which the practice is attended, we shall elsewhere have occasion to notice. As to the manner of pruning, or the form of the hedge, these seem, with many, to be matters of indifference, no attention being paid to dressing them in such a way as to have them broad at bottom, and tapering gradually towards the top; many of them being not only of one width from top to bottom, and not a few much heavier and broader above than they are below; it is obvious that such hedges can neither look well, nor be useful. The season at which they are trimmed is, in many instances, an improper one, for in place of choosing that time when the plants are least in danger of suffering from an effusion of their juices, which is either at a late period in the autumn, or very early in the spring, the pruning is given in the summer season, when vegetation is in its prime, and the plants are full of juices; the check and injury they must receive from having the whole of their extremities cut off at that period, may well be conceived.

In speaking of the treatment of hedge plants before they are put into the ground, notice has been taken of the necessity of preserving the roots as much as possible, and at the same time shortening the tops: this last operation has two good effects; for by curtailing the top and branches, the roots have less to nourish; and by leaving only two or three inches of the top above ground, in place of growing up with a single stem, it sends out two or three; and as these strike out from the plant so near the earth, each of them has the same effect, and strengthens the hedge as much as the original stem would have done by itself, with this addition, that in place of one prop or support, the hedge will have three or four. After this first pruning, however, no hedge should be touched, or at least very gently, for some years; from an inattention to this circumstance, and the injudicious application of the knife or shears, at an early period, many young hedges are rendered useless, which, under different treatment, would have made excellent fences, with one half the trouble that was required to destroy them. The practice of cutting over the tops yearly, which is done with a view to render the hedge thicker and more perfect, is one of these mistakes which we would naturally have supposed common sense and observation would have sooner corrected; the effect produced being, in almost every instance, the very reverse of what was intended: shortening the main stem of a thorn or any other plant, makes it brush out a number of small stems immediately at the place where it has been cut; and if this operation is repeated

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once or twice a year, every one of these is again subdivided, as it were, by sending out more branches; thus, in a course of years, during which, the hedge makes very small progress upwards, if it be examined, instead of being found to consist of strong vigorous plants, with a good main trunk, each reaching from top to bottom of the hedge, and a sufficient number of lateral branches throughout the whole length of it, it will be found, by such repeated cuttings, in the same stunted situation as certain young trees and shrubs, that are frequently cropped by sheep or cattle. From the repeated crops of young shoots, which the tops send out after every clipping, and the great quantity of nourishment necessary to support such additional numbers, the lateral shoots at the bottom, upon the strength and numbers of which the value of the hedge in great a measure depends, are stinted in their growth, and soon die; the hedge, of course, becomes open and naked at the bottom, and consequently useless as a fence. Where a hedge has been thus ruined, there is no remedy but cutting it over, close by the ground; this will immediately produce a number of healthy, vigorous, upright stems, which, under proper management, will soon form a good fence.

From the first year of planting, till the hedge has risen to the height of five or six feet, the main stems ought to be left untouched, and the pruning confined solely to the side branches, leaving those next the root pretty long, and gradually tapering towards the top; this pruning of the side branches will make them send out many new shoots from their extremities, which, by repeated trimmings, will become so thick as to fill up every interstice from top to bottom of the hedge, while the main stems, by being left untouched, continue their growth upward, till they arrive at the necessary height; when they may have their extremities cut off with perfect safety. When a hedge has attained the wished for height, all that is requisite afterwards, is regular switchings with a hedge-bill, preserving it pretty broad at bottom, and drawing it gradually to a point at top; this form of a hedge is pleasant to the eye, is well calculated to stand the weather, and by being thus above the nourishment that would have been wasted in supporting a thick, bushy, overgrown top, is retained by the branches at the bottom, which are thereby strengthened, and their numbers considerably increased; while the trunk, by having no more exertion to make in an upward direction, becomes every year stronger and thicker. A hedge of this sort in full leaf has the appearance of a solid wall; and when viewed after the leaves are shed, presents to the eye a set of massy growing piles, so strong and formidable, as to bid defiance to any attempts that may be made to break through them. Plate IV. fig. 29, represents a hedge trimmed in this way.

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Cutting down old Hedges.—The above directions and observations apply with strict propriety only to such hedges, as have been regularly attended to from the time of their being planted; but as there are innumerable hedges in the kingdom which by being neglected, have grown up to a great height, have become open and naked below, and bushy and unmanageable at top, it is of consequence to point out the means of reducing such hedges to a moderate scale, and rendering them useful. This purpose can only be effected by cutting them down, and procuring from their stumps a growth of new shoots, which, with proper management, will soon make a perfect fence. If the fields inclosed by such hedges are alternately in pasture and tillage, the period most proper for cutting them down, is when the field is to be ploughed. Under a corn crop, the confinement of the stock is no longer an object; and by the time the field is again brought under the plough, the hedge, if properly treated, will have acquired strength enough to become a good fence.

This operation is performed in several different ways; in the first, the hedge is cut over, about a yard above the surface, and is left in that state without any other pains being taken with it; if it has originally been good, and the plants thick enough at bottom, this kind of cutting will answer the purpose perfectly well, and in a few years the hedge will, with proper dressing, become both a neat and a useful fence. Plate IV. fig. 30, represents a hedge cut over in this way, with one year's growth of new shoots upon it.

When there has been a deficiency of plants, and the hedge is cut over in the manner above mentioned, innumerable gaps will appear, which, without some art, it will be impossible to fill up. It has also this farther disadvantage, that if either horses or cattle attempt to leap into, or out of, the inclosure, the sharp points of the stakes are apt to run into their belly: this accordingly often happens, and many valuable horses and cattle are killed in that way.

The second, and indeed a preferable mode of cutting down old hedges, is to cut a fourth part of the plants over, to the height which the fence is intended to be made, and to bend down and warp the remaining three-fourths with these upright stems. Plate IV. fig. 31, represents a hedge done in this way, which very effectually cures the gaps and openness below, and with slight attention soon makes a good fence.

The third way of cutting over old hedges, is to cut them close by the surface; this practice, when the plants are numerous, and there are no gaps in the hedge, answers very well; but when there is a deficiency of plants in any part of the hedge, the want

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will be very apparent. This last mode, though much inferior to the one immediately preceding, is nevertheless greatly preferable to that first described, as the young shoots sent out from the stumps, by being so near the ground, will in some measure remedy the defects occasioned by the want of original plants; whereas, when the old plants are cut at the distance of about a yard, or four feet above the surface, the young shoots produced by the cutting will be so high, as to leave the hedge open below.

The last way of cutting down old hedges, and which, by the by, is but very little practised, is first to cut them down even with the surface, and afterwards to cover the stumps completely over, with the earth taken out of the ditch, or from the way side. When this is carefully done, every single root sends out a great number of young, vigorous shoots, which, by branching out from the stump below the surface, each of them sends out roots, and acquires an establishment for itself; by that means the bottom of the hedge becomes so thick, that neither sheep, cattle, nor indeed any animal, can find its way through it.

In whichever of these ways the hedge is cut down, the directions formerly given for the management of young hedges, should be strictly attended to, as soon as the young shoots have made some progress; that is, the side branches should be trimmed, and the hedge put into a proper shape, preserving it broad and full at bottom, and tapering gradually towards the top. The same caution is also to be observed with regard to the upright shoots, none of which should be shortened till the hedge has attained the wished for height. It is surprising what close beautiful fences are raised, in this way, in a few years from the stumps of some overgrown useless hedges; which, at the same time, with their being naked below, and of course faulty as fences, occupied four times the space they ought to have done, to the great loss both of the proprietor and farmer.

The observations formerly made, with regard to the proper season for pruning and switching young hedges, apply with equal, indeed greater propriety to the cutting down of old ones; as, if this operation is done at an improper season, from the largeness of the stumps, the extent of wounded surface exposed to the weather, and other circumstances, the plants are in imminent danger of being destroyed: indeed this very often happens when, through ignorance or inattention, the proprietors of hedges have them plashed or cut over during summer. It is unnecessary in this place to enter into any digression as to the use of leaves and branches, to plants of every description; it is sufficient for the present purpose, to state what experience and common sense have abundantly proved; *viz.* that the loss of either, especially when the plants are in a

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growing state, and the juices circulating through them, is in most cases attended with the destruction of the plant; indeed the thing speaks for itself; the juices of the plant, instead of being employed in nourishing the top and branches, flows in great abundance through the section of the trunk, and by finding so ready an exit, draws from the root a quantity of nourishment, far exceeding the proportion required for its former support: by such an unusual drain, the plants are exhausted, or, as is commonly said, *they bleed to death.* It is to be observed, however, that every description of plants, are not equally affected by a summer cutting; those that are most juicy and succulent, and have the largest circulating vessels, always suffering more, than such as are of a harder texture, have smaller pores, and less sap circulating through them. The *birch, larch, poplar, willow,* and in general all plants that contain a large proportion either of *resinous* or *saccharine* matter, are to be ranked in the first class; the different kinds of *thorn, crabs,* &c. &c. belong to the second; the former are almost infallibly killed by a spring or summer pruning, while the same operation is often practised upon the latter with little apparent injury.

But though we thus readily admit, that one description of plants will survive an operation, by which others would be killed, it by no means follows, that they are not injured thereby; there are, indeed, too many proofs to the contrary, as in almost every county there are thorn hedges met with, that have been plashed or cut over in summer, and which, though they have not died in consequence of the operation, yet by the loss of juices, and the exposure of their naked trunks, and wounded extremities, to the parching rays of a summer sun, have been so much weakened as to prevent them from putting out new shoots, and have ever afterwards remained in a naked state, exhibiting an appearance no way better than that of a dead hedge. This picture is the very reverse of what, under different treatment, would have been the case; as, when the old plants are cut over at a proper season, a healthy luxuriant crop of young shoots never fails to be produced.

The proper season for cutting over hedges is either at a late period in the autumn, or very early in the spring; at both of these periods the plants are equally safe from injury; at the former, the juices are retiring towards the root, and early in the spring they have not begun to rise. In either case, no danger whatever can arise from the bleeding of the plants, as, long before the circulation takes place, the wounds occasioned by the cutting will be completely healed; all cuttings or trimmings ought therefore to be done at one or other of these seasons.

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Filling up Gaps in Hedges.—When young hedges are planted, if the plants made use of are of a nature suited to the soil, the hedge may be kept free of gaps with very little trouble; for that purpose it is necessary, about the end of the first autumn after the hedge has been planted, to examine it carefully throughout its whole extent, take out such plants as are either in a decayed sickly state, and those that are actually dead, and fill up the spaces they occupied with the strongest and most vigorous ones that can be found; where this care is taken for the first two or three years, there will be no defects in the hedge, which will be uniformly thick and strong throughout. Thus far, of young hedges: but when old hedges are meant to be cut down, that have many gaps or open spaces in them, so wide as to prevent the possibility of the young shoots filling them up, some expedient must be had recourse to, in order to render the fence complete. This purpose may be answered in different ways; the easiest, and indeed the most common method is, for the hedger, when he comes to a place where any of the plants are wanting, to take one of the strongest plants next to it, and after giving it a gentle stroke with the hedge-bill, to bend it across the opening, and entwine it with the thorns on the opposite side; indeed, as has been already stated, some have a custom of cutting down only a fourth part of the stems, and warping the remainder with these, which appear like stakes drove into the earth. Where the hedge is shortened to within three or four feet of the ground, both of these answer pretty well; and the openings, which would otherwise have been left, in some degree filled up: but when the old hedge is cut close to the earth, other methods of supplying the defects become necessary. One very simple, and at the same time very effectual mode, consists in first digging the ground pretty deep with a spade, and taking one of the strongest plants on each side of the opening, that have been purposely left uncut, removing the earth from their roots so much as to loosen them, and admit of their being bent down, and laid close to the earth in the opening, as represented in Plate III. fig. 24; they should then be fastened down with wooden hooks or pins, and entirely covered throughout the whole of their length with earth. Where this is properly executed, the plants so laid down, send up a great number of young shoots, which very soon fill up the vacancy: where it is practised upon a hedge that is cut over close by the surface, no other care is requisite; but when it is done with hedges, that are cut at three or four feet above it, there will be a necessity for placing a temporary paling in the gap, to protect the young shoots from injury, till they acquire a sufficient degree of strength, as represented in Pl. IV. fig. 25.

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There is scarce any thing attempted by farmers, in which they are so unsuccessful, as in the mending of hedges; in some cases the defect is attempted to be supplied with young plants, which from want of attention very seldom succeed, as they are not only shaded by the strong old plants on each side, but are also deprived of their nourishment, by their roots spreading into the vacant space.

To render an attempt to mend the defects of an old hedge, with young plants, successful, two things are absolutely necessary; the first is, that the whole of the roots of the old plants, which extend themselves into the opening, shall be entirely cut off; the next, that the hedge shall be cut down close to the earth, for at least a yard or more on each side of it. By cutting away the roots which extend themselves into the opening, the young plants are prevented from being robbed of their nourishment; and cutting down the old ones, for a little distance on each side, keeps them from being shaded, and allows them to enjoy the full benefit of the light and air: cutting down so much of the old hedge, no doubt, renders the opening larger, and of course requires more paling to supply the defect; but this extra expence will be more than compensated by the success with which it will be attended.

In many instances these vacancies are filled up with dead wood; indeed it is a common practice after a hedge is dressed, to cram the greatest part of the prunings into these spaces, and under the bottom of the hedge, where it is any way open or naked. The most perverse imagination could hardly suppose any thing more absurd; for if it is the wish of the owner, that the plants on each side, should send out new branches to fill up the openings, the purpose is completely defeated by cramming them full of dead brush-wood, which not only prevents the extension of the branches, but from the violence and injury that is committed in thrusting in dead thorns, the plants are often materially hurt; and when this brush-wood decays, the opening, in place of being diminished, is considerably enlarged; the mischief is the same, where they are thrust under the hedge, the practice of which when continued never fails to render it naked at bottom. The use of stones (represented in Pl. IV. fig. 27.) for mending the hedges, is equally absurd and pernicious; where dead wood is used in the way above mentioned, the hedge instead of being improved is made worse. The utmost that can be said of stones is, that though they do no additional harm, the hedge is not bettered by them, and from the opening being filled up in that way, the defect is perpetuated, and both the usefulness and beauty of the fence impaired.

In some instances where the attempt has been made, the defects of grown up

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hedges have been very completely, and indeed almost immediately repaired, by planting strong beeches in the openings; these should be at least six or seven feet in height, and should be supported by a couple of pieces of coarse paling, put across the opening. If planted early in the winter, they suffer no check whatever, and grow so vigorously in the spring, as to fill up the vacancy the first season, (see Pl. IV. fig. 26.)

The ground in this, as indeed in every other case where young plants are used, should be well dug, and enriched either with dung or compost; the plants should be the healthiest and strongest that can be procured, and the whole of their roots carefully preserved.

Diseases of Hedge Plants.—The principal disease to which hedge plants, especially thorns, are liable, is being covered with moss; which, when it arrives at any considerable height, gradually destroys them. Upon certain soils such as *till*, or cold wet clay, every description of woody plants are subject to this malady, and as it is evidently owing to the nature of the soil, it becomes a matter of importance to be able to apply a proper remedy.

Lime is well known to be unfriendly to the growth of every description of moss, and in every instance where it is applied the moss disappears. This circumstance once known, furnishes a cheap and effectual remedy, both for preventing the disease upon young hedges, and curing it upon such as are grown up.

If the hints formerly thrown out, with regard to the preparation of the soil before a young hedge is planted, are properly attended to, and a sufficient quantity of lime incorporated with the earth; let the former quality of the soil be what it may, its nature will be so much altered, as effectually to secure the hedge from every risk of being hurt by moss.

The same remedy may be applied with equal success to old hedges, that are overrun with this vegetable vermin: and in which, though there may be plants enough in the ground, yet they are of no value, from the want of branches. To recover such hedges, and render them afterwards good fences, they should be cut down close by the surface, cleared completely of weeds, and the earth well dug, for at least half a yard on each side of the roots. After this operation, which should be done about the end of autumn, the spaces so dug should be well limed upon the surface, it should be suffered to remain in that state during the winter, and early in the spring dug again, and the lime pointed in and incorporated with the soil. In the cases where this has

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been done, the plants have sent out a number of useful vigorous shoots, which soon made good hedges, and no moss has afterwards appeared. It is from these experiments to be presumed, and we hope experience will confirm the idea, that in every ease where either trees or hedge plants are infested with moss, the use of lime in the way pointed out, will prove a sufficient remedy for the evil.

Before quitting the subject of hedges, we beg leave to mention the practice of many of the English counties, where it is common, after the plants have attained the wished for height, to cut their stems about half through, within a few inches of the bottom; then bend them a little down, all in one direction, and bind them together at top with willows, as represented in (Pl. IV. fig. 28.) This, when properly executed, forms a very pretty neat looking fence, but is liable to several objections. In cutting the plants so near the root, unless great pains are taken, there is a chance of cutting them too much, indeed in some instances they are cut through altogether; the value of the hedge is by that means lessened, and gaps appear in many parts of it.—The binding at top being of dead wood soon decays, and the plants either rise up, if they have not been very much cut, or if the cutting has been deep, they are apt to be blown to one side, and even broke over by the wind. Owing to these causes, many hedges where the plants are sufficiently numerous and healthy, and which with little trouble would have formed beautiful and useful fences in a short time, have their value impaired, and are rendered faulty and defective.

Cutting the stems too much, subjects them to another evil; namely, the mischief arising from heavy falls of snow, which when the quantity is considerable, especially if there is a high wind to accumulate it about the hedge, it is thereby pressed down, and many of the plants broke entirely over.

The practice formerly noticed of cutting one-third of the stems over, at the height of about four feet from the surface, leaving those as standards, and warping them with the others that have been left of the full length, makes a much stronger fence, and one that is less liable to injury, either from the attempts of cattle, or from the wind, or heavy falls of snow. What adds to its value is, that the warping and binding of the bushes being done with live wood, in place of decaying, as is the case when willows or hazels are made use of, grows stronger with time, and the plants are in the end so completely interwoven, as to form a fence which nothing can exceed, either for closeness or durability.

The way in which this operation is commonly done, is liable to one objection,

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however, it being customary to trim away the whole of the branches, before the stems are bent down; this renders it no doubt a much easier business for the workman; but it materially injures the hedge, leaves it thin and open in many places, and gives it not only an unpleasant appearance to the eye, but makes it less useful as a fence. This defect is not in general repaired for a year or two; whereas, by leaving as many of the side shoots as possible, upon that part of the plants that are to be laid horizontal, and, after the whole hedge is warped, trimming it neatly with a hedge-bill, it will form at once a solid and useful fence. Pl. IV. fig. 30, and 31, represent hedges done in this way.

It should never be forgot, that in every operation of this kind, when old hedges are either cut over, or bent down, the ground on each side should, as soon as circumstances will admit of it, be completely dug, cleared of weeds, and the earth laid up to the roots of the plants. It is truly surprising what numerous, and luxuriant shoots the stumps send out, when managed in this way. While, on the contrary, when these necessary operations are neglected, fewer shoots proceed from the old trunks, and of these few, a considerable proportion are choked by the weeds.

Hedge Plants.

Throughout the Island, almost every description of plants, whether trees or shrubs, are made use of for hedges; in some cases the hedge is made entirely of one kind of plants, in others of two or more; and in not a few instances, it consists of a mixture of all the different kinds. The following list comprehends those that are principally used for that purpose:

1. White thorns.	10. Larch.
2. Black ditto.	11. Hazel.
3. Crabs.	12. Privete.
4. Briars.	13. Allar, or alder.
5. Holly.	14. Elder.
6. Beech.	15. Whins, or furze.
7. Willow.	16. Brambles.
8. Birch.	17. The mulberry.
9. Poplar.	18. Miscellaneous articles.

It has been observed, that a hedge is sometimes composed of one kind of plants only, and sometimes of a mixture of different kinds.

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The inconvenience of mixing different plants in the same hedge is very obvious; shrubs, or trees of different kinds, if put into the same hedge, neither grow equally, or are in leaf at the same time; by this means both the appearance, and usefulness of the hedge is hurt. It is disgraceful to observe the motley mixture of plants, that are crammed into many of the hedges in England; especially that description known by the name of Hedge-and-bank. This seems to be the oldest kind of inclosure known in England, and is beyond dispute the worst. The plants employed, are commonly a mixture of hazel, elder, sweet-briar, honeysuckle, &c.; these from their nature, most of them wanting prickles, and growing so unequally, are ill calculated either to confine the stock while the field is in pasture, or protect the crop from injury, when it is under the plough. This disadvantage both proprietors and farmers are sensible of; but though the remedy is easy, yet so indolent are they, and so much wedded to old customs, that it is almost impossible to stimulate them to any exertion.

In those counties where this kind of fence is so common, these high banks of earth might be converted into a valuable and lasting source of improvement for the fields which they surround; good earth of every kind is known to act as a manure, especially if it has been any time raised above the common surface, in the form of *banks* or *mud-walls*; perhaps in most of the fields inclosed in this way, a quantity of valuable earth might be procured, sufficient to cover the whole surface to a considerable depth; and a better fence raised upon the foundation, in a few years. These fences should consist entirely of one species of plants, unless where a few willows, or hazels are wanted to bind the hedge together. Having enumerated the plants at present in use, we proceed to take some notice of each separately.

White Thorns.—White thorns, or quicks, as they are commonly called, are reared with great ease, and under proper management soon make useful and handsome fences upon all dry soils, provided the situation is not too high and exposed. In such places, though the plants do not perish entirely, they never attain the strength or vigour necessary to make a good fence.*

* In cases where the natural surface of the ground is rather too moist for white thorn, the excess of damp may be carried off by a ditch on one side of the plants in the usual way.

In marshy situations where a ditch on one side would be insufficient to lay the soil dry enough for the success of white thorns, it ought to have a drain on each side of the bank on which the thorns grow, and which would be particularly favourable for the growth of ash poles.

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In every case where thorns are planted upon the common surface without a ditch, and upon dry ground that has been previously prepared by dung, lime, &c. they grow better than where ditches are used; because, as was formerly observed, the ditches serve as open drains to carry off the moisture, a circumstance which in dry seasons is often very detrimental to the growth of the hedge.

Except weeding, the thorns should not be touched for the first four or five years of their growth, unless it be to crop the most luxuriant of the lateral shoots; at the end of that time they should be completely trimmed, and put into shape, leaving the top shoots untouched, till the hedge attains the necessary height; when this stem ought also to be cut over, and its farther growth upwards prevented by regular yearly cuttings. This treatment, and its good effects, have been already so fully and particularly described, as to render any addition to what is here said unnecessary.

Black Thorns, Crabs, Briars, &c.—These plants should be treated in nearly the same manner as the white thorn. There is, however, one remarkable difference between them, which is, that both the crabs and black thorns will thrive, and become good fences, in situations where the white thorn would perish: upon *tills*, and cold clays, for example, many fields of that description are completely inclosed with them, which could never have been rendered fencible, if white thorns had been employed.

Holly.—The holly, when properly attended to, forms a thick and beautiful fence, and has an advantage over most others, in affording the same degree of shelter at all seasons. It grows well upon all soils, but particularly upon deep and moderately dry loams. Its progress is, however, slow even in the most fortunate situations, which renders it unfit for common use; unless in pleasure grounds, or places where taste or fancy require it.

Beech.—Hedges made with this plant have not hitherto been very common; they are, however, fast coming into use, and perhaps will soon be the only kind employed in the uplands, or upon the cold wet soils in the lower districts of the kingdom; for these situations, so far as the experience of several parts of Scotland can ascertain that point, they are remarkably adapted.

In East Lothian there are several tracts of land, the soil of which is of a very inferior quality, that have had their value greatly increased, by inclosing them with beech hedges, upon which thorns were formerly tried without success, and much trouble and expence incurred in the attempt; while the beeches, which originally cost no more than the thorns, without any trouble very soon become good fences. Along with their

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growing so readily in these unfavourable situations, they possess a property well suited to a cold or exposed country; namely, that of preserving their leaves through the winter, and indeed till an advanced period in the spring; by which they afford shelter to the grazing stock, and also to the pasture in the early part of the season, when it is apt to be hurt by the cold nipping frost winds.

Birch.—The birch is peculiarly adapted to cold clays,* where it seldom fails to thrive, and form a good fence; some caution, however, is necessary as to the management of it. In all cases where it is intended to cut or plash it, the operation should be done about the end of autumn, as the juices are at that time retiring to the root, and long before the circulation is again renewed, the wounds are healed: whereas, when the cutting is deferred till the spring, or beginning of summer, when the circulation is going on, the juices flow out by the wound, and continue to run off in that way during the whole of summer; by which means the plants are so weakened and exhausted, that many of them die: a misfortune which is entirely prevented by cutting about the end of autumn, or during the winter.

Willows, Poplars.—Upon all wet or marshy grounds, these plants thrive and are extremely useful, in completing inclosures in many situations, where other plants would either perish entirely, or remain in a dwarf stinted state. In Huntingdonshire and several of the fenny parts of England, these plants, in conjunction with the alder, form almost the only description of live fences that are met with: their value in these parts is well known; and in every similar situation throughout the kingdom, if proper trials were made, they would be found equally useful. Hedges made with willows, have an advantage over almost every other, as, after the hedge has arrived at a certain height, and is properly laid down and bound together, the young shoots may be annually taken off, and sold to basket makers for a considerable sum of money. They have another obvious advantage, *viz.* the ease with which they are propagated; being raised from simple cuttings, without any other trouble, than that of merely sticking them into the earth. Where this is practised, and in most situations it may be done with great ease, the farmer or proprietor will not only have his fields inclosed, but the fence will be converted into a source of revenue, by the sale of the young shoots yearly.

Where the Huntingdon willow is used, a farther emolument may arise to the proprietor, by allowing a certain proportion of the plants to run up into trees; with very

* It is the only plant which succeeds in the sandy rabbit warrens of St. Leonard's forest, Sussex.

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little care they soon arrive at a great size, and are of considerable value; the wood is soft, easily wrought into any form, takes a fine polish, and can be stained of any colour. These qualities render it a great acquisition to cabinet-makers and others, in the making of fancy articles; its introduction in these branches, would in a great measure set aside the use of satin wood, and several other kinds brought from the Spanish Main, and the East Indies, which at present cost a great deal of money, and are in no respect preferable to the Huntingdon willow.

The use of willows, poplars, &c. is not confined solely to wet or marshy grounds, they thrive upon almost every soil; and, indeed, make more progress upon such as are moderately dry, than upon wet lands; upon the latter, however, they grow better than any other plant, and on that account deserve a preference.

There is one circumstance connected with the use of willows and alders, that deserves particular notice. Both of these plants contain a very great proportion of saccharine matter, which under proper management might be converted to some useful purpose. In speaking of the birch, the same circumstance ought to have been noticed, as that plant also abounds with saccharine juices: from all these plants we have been able to produce fermented liquors of a good quality, and even to distil spirits. Trials diligently made upon them by persons of skill, may perhaps lead to very important consequences, and be the means of lessening the dependance of Great Britain upon the West Indies, for some of the productions brought from that quarter.

Hazel, Elder, &c.—These plants grow well upon all dry soils, and if properly managed by laying, wattling, &c. produce wood enough to form a very sufficient fence; but their want of prickles renders them less eligible than thorns.*

Where the proprietor is disposed to take the necessary trouble, the hazel may be rendered very useful, by cutting the hedge within four feet of the surface, every second or third year, and selling what is cut off to coopers or basket-makers: hazels are well known to make the best and most durable hoops, and generally bring a high price for that purpose.

Larch.—The larch has not hitherto been much used as a hedge plant; from its

* The Elder possesses a property, which along with the beauty of its flowers, will give it a preference to most other plants in many situations; namely, that of its being propagated from cuttings, with as much ease as the common willow.

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growing so readily, however, and bearing the operation of clipping so well, it seems very much adapted for that purpose.—In exposed situations, where thorns would fail, the larch will be found an excellent substitute, and many fields may be inclosed with it, that would otherwise remain open.

Where it is intended to inclose a field with larches, the plants made use of, should be at least seven years old; and the strongest that can be obtained of that age. They should be taken up in the most careful manner, preserving the whole of the roots, and planted in a trench, where a considerable quantity of dung or compost has been put. The most proper season for this operation is about the end of November, or in the early part of January; at either of which periods, if they are carefully lifted, and re-planted without any destruction of the roots, they will suffer no check whatever, and grow readily and vigorously in the spring.

When a line of hedge has been completely planted with larches, of the age and size above mentioned, they should be bent down, their tops properly entwined, and the side branches afterwards trimmed with a pair of shears: this operation, by cutting off the extremities of the lateral shoots, will cause them to brush out a great number of new ones, which will soon render the hedge very thick.

But, if it should be preferred to allow the plants to remain upright, it may be done; the hedge will in that case look better, but will not so soon be useful. It may, however, be strengthened and protected for a time by a slight paling; and when the plants have attained a proper size, their side branches may be so interwoven and bound together, as to make a very good hedge. It is, however, worthy of notice that the tops ought never to be allowed to exceed the height of six feet; because, after they pass that height, the wind has so great an effect upon them, as to destroy any binding that may be made with their lower branches; cutting the tops has also another beneficial effect, namely, that of making them push out more vigorously below.

Larches have, however, one defect in common with hazels and some other plants, *viz.* the want of prickles, which certainly impairs the value of any fence made with them; as neither sheep nor cattle are disposed to respect any hedge, so much as those that are made with prickly plants.

Whins, or Furze.—In speaking of the plants adapted to the different soils, it was observed that some benefit might arise from noting, particularly the indigenous plants that grow, and attain perfection, in various situations. There is perhaps no kind of fence to which this observation is more strictly applicable than whin hedges; that plant

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being known to grow spontaneously, and attain a great size upon soils, and in climates, where scarce any other would live.

In all cases, therefore, where whins are found growing naturally, and of any considerable size, hedges of them may with safety be attempted; but as the whin seldom grows to any considerable height, hedges are not often made with it, either upon the plain surface, or in conjunction with a ditch. It is generally upon the top of a pretty high bank, or mound of earth, that whin hedges are sown; these banks have sometimes an equal slope on both sides; in other cases they only slope on one side, while the other is perpendicular, and faced with stone or turf. Pl. IV. fig. 32. represents a whin hedge upon a bank faced with stone, and Pl. V. fig. 33. one upon the top of a bank faced with turf. This fence, when a sufficient number of plants can be reared, and brought to perfection, is a very good one, and from its numerous prickles, very effectually prevents both horses, sheep, and cattle, from attempting to break through it.

It has however one defect, and that is considerable; being raised a good deal above the common surface, the plants are exposed to many accidents, arising from drought, frost, &c.; accordingly, it often happens in severe winters, that whole lines of whin hedges are killed at once. In the severe winter of 1794-5, numerous instances of that kind happened, both in the North of Scotland, and in some of the Northern counties of England; by which many fields that were, before the commencement of the winter, completely and substantially inclosed, were in the spring, from the frost destroying the plants, left in a naked exposed state. The Author of this Paper had occasion to see many instances of this kind the following summer, and heard much murmuring and regret amongst those concerned on that account: all of them alleging that thorns would have stood the winter infinitely better.* That they were mistaken is very certain, and that the failure of the hedges, was owing more to their being raised so high above the common surface, and thereby exposing the roots to the operation of frost, drought, &c., than to the nature of the plants of which they were composed; this is abundantly confirmed by remarking what happens in England. In severe winters, that description of fence, which we have already had occasion to notice, by the name of Hedge-and-bank (or hedge on the top of a bank), and which consists of a mixture of almost every tree or hedge plant now known, is very often

* Whins or furze, are also of various kinds; and it is believed that the Scotch are hardier, and less liable to be injured by the frost, than the English.

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completely destroyed. The misfortune in both cases is owing to the same cause; namely, that of being raised so much above the common surface, having their pasture so much curtailed, and their roots so much exposed.

In making whin hedges, it has been disputed whether sowing the seed or transplanting is the most eligible. If it were fairly ascertained, that whins could be transplanted with safety, there can be no doubt, that hedges would be much sooner made in that way than by sowing.—A few experiments very carefully made, and which were completely unsuccessful, go a great way to destroy the idea of whin hedges being reared in any other way, than by sowing the seed: whins, it is true, if taken out of the earth either at a late period in the autumn, or very early in the spring, and immediately replanted, will continue to grow afterwards, especially if their roots are completely preserved, and perhaps a ball of earth taken up along with them; but notwithstanding every care that can be taken, they very often die: the wood is of a hard crabbed nature, close in the pores, and sends out new roots very reluctantly; in that way, unless the season is very favourable, they perish entirely. In short, it would appear that the whin does not agree with transplanting, that it often fails when the trial is made, and that the only certain way of rearing good whin hedges, is by sowing the seed, which, though it requires considerable time and care to bring the plants to perfection, is in the end more certain.

There is one circumstance connected with whin hedges, highly deserving of notice; after growing to a certain size, they are apt to turn open and naked at bottom. In that way, they are not only less valuable as fences, but are more liable to be killed by frost, or drought. When a whin hedge has run up to a considerable size, and is become *shanky* and naked, if the proprietor wishes to improve it, he should cut it down close by the ground, take out the weeds, and lay the earth up to the roots; by this operation an immense quantity of new shoots will be produced, which, with proper care, will soon form a thick impenetrable fence.

Of the attention necessary to keep a whin hedge in good order, most people seem to be ignorant. Almost every other description of plants, with which hedges are made, have some weeding, trimming, and dressing bestowed upon them; the whin alone is left without any of these, of course it runs up, grows unmanageable, and becomes naked, in the manner we have noticed.

It is somewhat surprising that farmers have not taken a hint, from observing what happens to whin bushes, that have been much eaten by sheep, or cattle; the cropping

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by these animals, resembles a clipping, and has the effect of making them grow uncommonly thick and compact; witness the great numbers of them that are seen upon many of the moors in the kingdom, which, by frequent cropping all round, appear like so many small pyramids; and are so close, as to bid defiance both to the weather, and the attempts of animals to break through them.

If a similar mode were adopted with all young whin hedges, very beneficial effects would arise from it: if the seed were sown in a drill, the plants would come up uniformly in a line; and if they were afterwards trimmed or clipped annually at the sides, leaving the top shoots entire, the fence would soon become *thick, beautiful, and valuable*, and would by its closeness so completely exclude the frost, as to preserve the plants in a great measure from the misfortune of being killed by it, an accident to which whin hedges are so liable. In exposed situations, where other plants do not thrive or grow readily, the whin under judicious management promises to be extremley useful.

Brambles.—It has been recommended by many, to mix brambles with hedge plants, with a view to render the hedge thicker and stronger; we have already noticed the disadvantage of mixing different plants in the same hedge; to this particular plant the objection applies with great force. Though the bramble sends out numerous long shoots every year, these shoots seldom live above two, or at most three years, and die nearly in the same manner as the *rasp*. In a hedge, therefore, where brambles are numerous, and have their branches interwoven with the other plants, by the yearly decay of a certain part of their shoots, they soon fill the hedge with dead wood, which has not only an ugly appearance, but is also hurtful to the other plants, of which the fence consists. Besides, the leaves of the bramble are so broad, and numerous, as nearly to deprive every other plant with which they are mixed, of the benefit both of the sun, and atmosphere. This is not opinion merely, it is confirmed by facts, as in almost every case where there are brambles in hedges, they establish themselves at the expence, and in general the utter ruin, of every other plant.

If the shoots of the bramble were like those of *thorns*, or indeed any other description of hedge plants, and were capable of filling up the spaces they occupy, and living for a number of years, a very good and handsome fence might be made with them in conjunction with a railing, with which they might be warped; such a fence, if the plants were sufficiently numerous, might be made in a couple of years, which, along with its inclosing the field, might become an object of profit, on account of

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the fruit, which when the plants are reared above the common surface is very plentiful, and might be employed in making either a species of *wine* or *brandy*. This is no visionary idea, the thing has been long known and practised in France, where they make a great quantity of most excellent brandy, from the fruit of the bramble annually. In an after part of this Paper, we will have occasion to mention other plants, that can be propagated with great ease, and which if employed either by themselves, or in conjunction with others, would not only make excellent fences, but would produce immense benefit, both to the owner, and the public. *

Mulberries.—The mulberry is known to grow and thrive, not only in England, but in North Britain; hitherto it has been but little cultivated for any purpose, but there is great reason to believe that the general use of it for fences, might prove highly beneficial, not only for inclosing the lands, but for food to cattle, &c. who are known to be uncommonly fond of the leaves; and also for the sustenance of silk worms. Several successful attempts have been made to propagate this plant, for the purpose of feeding silk worms; one in particular at Dalkeith in Scotland, where there are above a dozen very beautiful mulberry trees, upon which silk worms are regularly fed; and though this experiment has been made by the owner, more from motives of curiosity than profit, the success of it has been such, as to afford an encouraging prospect to any attemps that may be made upon a larger scale. For the raw material of silk, our present dependence is upon foreign nations, and much money is annually sent out of the kingdom to procure that article; could we produce it at home, the

* An intelligent French emigrant, the Author of a work lately published at Edinburgh; entitled, *Promenade autour de la Grande Bretagne, par un Officier Français Emigré*; takes notice of the *sloe*, and the uses to which it may be applied. Speaking of the propensity of the Highlanders to the use of spirits, he says,

"As nothing can prevent the inhabitants of these mountains from drinking strong liquors, I "shall endeavour to procure for them, one more agreeable to the palate, and wholesomer than *their* "*whisky*. There are various districts in Great Britain, where sloes are produced in abundance. "I have seen the peasants in the neighbourhood of Thionville in France, make a spirituous liquor "of the juice of the sloe, which they prefer even to wine. The mode they pursue is very simple; all "they have to do, is to bruise the fruit and the kernels thoroughly, then to press out the juice; and "after subjecting it to the process of fermentation, distil it in the same manner as they do brandy "from wine."

There can be no doubt but the juice of brambles, currants, gooseberries, and other small fruits, may be manufactured into spirits in the same manner.

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advantage to the nation would be great, not only by keeping the money at home, which is at present unavoidably expended in the purchase of raw silk; but by the employment that would be thereby given to an additional population: and what would encrease the value of such employment, it would be given chiefly, either to infirm old people, who are incapable of hard labour, or to young girls and boys, whose tender years, and want of strength prevent them from engaging in more laborious employments.

Miscellaneous Articles.—It is proper to bring under the consideration of the reader, in a general treatise of this nature, the possibility of making use of the smaller kinds of fruit trees or shrubs, not only as a means of inclosure, but as a valuable source of produce. For instance, few plants yet known grow more readily, or seem better adapted for hedges than the gooseberry; some varieties of which rise to a considerable height, grow very thick, and by the strength and number of their prickles, very effectually prevent any animal from attempting to break through them. In the lower districts of the kingdom, where the soil is deep and of a good quality, and where it is intended simply to inclose the field, very good hedges may be made with gooseberries,* which, at the same time that they answered every purpose of a fence, would be valuable on account of the fruit, which might be converted to many useful purposes. The gooseberry, the white currant, and several of our small fruits, are known to be equally rich, indeed richer than many varieties of the grape, and when properly treated, yield both brandy and wine, of a quality no way inferior to some of the best foreign wines.

Walls.

These are made with different materials, and differently denominated in various parts of the kingdom; in England they are uniformly known by the name of walls; in Scotland, they are more commonly called dikes, and are distinguished as follows,

1st. Dry stone walls, coped and uncoped.
2d. Stone and lime ditto, coped and uncoped.
3d. Galloway dike or wall.
4th. Stone and clay, coped and uncoped.
5th. Stone and clay harled, or dashed with lime.
6th. Dry stone, lipped with lime.

* A gooseberry has lately been introdneed into Scotland, known by the name of the Ironmonger, which seems well adpted for a fenee, as it grows higher and stronger than any other yet known.

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7th. Dry stone, lipped and harled, or cast.
8th. Dry stone, pinned and harled.
9th. Brick walls.
10th. Frame walls.
11th. Turf ditto.
12th. Turf and stone in alternate layers.
13th. Mud walls, with a mixture of straw.

All of which, when properly executed, are valuable as fences; some of them, however, are of a very perishable nature, and though erected at small expence, their cheapness is more than counterbalanced by their transitory value; amongst these are to be ranked (Pl. V. fig. 38, 39, and 40), all of which are in the highest degree perishable, and should never be had recourse to, except in cases where better materials are not to be had. The other descriptions of walls, when properly executed, will last many years.

As there are certain points connected with the building of walls, the observance of which is essential, not only to give them a decent appearance, but also to make them last; we think it necessary to notice them before entering upon the separate account of each.

1. That the stones shall be either taken from a quarry, or consist of the largest kind of land-stones, broke or blown in such a manner, as to take away their round shape, and give each of them a sufficient degree of flat surface, to bind and consolidate the building.

2. That they shall be built by masons sufficiently experienced, who are able to give each stone as much flat surface as possible, and carefully pin or fill up every vacuity between them with small stones.

3. That the wall shall have, as far as circumstances will admit of it, a dry foundation, sunk so deep as to place it beyond the reach of frost, and other accidents to which walls built upon the common surface are so very liable.

4. That the wall shall be so broad at the foundation, as to admit of a gradual taper upwards, till it terminates in a breadth of about 10 inches, where the coping is applied; the readiest way of preserving this shape is by a frame and plummet, which serves as a complete direction to the mason, and keeps the walls of an uniform taper throughout.

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5. That the coping shall consist of materials that cannot be readily overturned, or removed; as, upon the manner in which it is finished, much of the future value and durability of the wall will be found to depend.

An attention to these points is essential, indeed indispensable in the formation of this description of fences.

1st. *Dry Stone Walls.*—Dry stone walls are sometimes erected by common labourers, with the round stones gathered from the fields, and coped with sod; in other cases, they are made with quarried stones, upon which some pains have been bestowed to put them into proper shape; a third kind, known by the name of Galloway dike, and so denominated from the circumstance of its being originally used in that country.

The first of these, *viz.* the wall or dike made with round or land-stones, by labourers, and covered with a coping of sod, is a very indifferent fence. In most instances, it is not only very ill constructed as to shape, being of one uniform thickness from top to bottom; but the stones, from their round figure, do not present a sufficient surface to each other, to bind and give stability to the building.

This fence has long been known, and is still very common in the remote parts of the country, upon estates where the first rude essay is made in the way of improvement, and where masons cannot readily be had. In such situations it has a two fold benefit; the surface is cleared of many stones, that would otherwise have presented a considerable obstacle to its cultivation, and the field is at the same time inclosed. But, though these objects are accomplished for a time, their benefit is not permanent, as the wall is perpetually tumbling down; even the cattle rubbing against it make considerable gaps in many places; in that way, great trouble and expence are annually required to keep it in repair. Pl. V. fig. 34. represents a dry stone wall coped with brick, and fig. 35. represents a dry stone wall, coped with turf.

When the stones with which dry walls are built, are quarried, and done by skilful masons, broad at bottom, tapering gradually upwards, and finished at top with a substantial coping, the fence has a very neat appearance, and has been known to last thirty, and even forty years without repairs. A good foundation is highly essential in the construction of this fence; from nine to twelve inches is the smallest depth that it should be below the common surface, especially if the soil is open and porous, and the largest and heaviest stones should always be laid undermost. In cases where the

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materials do not require to be brought from any great distance, a hundred yards in length, by six feet in height of such a wall, may be built for £18. or 20.*

Where dry stone walls are built, that which we have just described deserves a preference, on account of its neatness and durability. It is not only much cheaper than one made with stone and lime, but is equally useful, looks as well, and admits of being practised in many situations, where lime is either exceedingly scarce, or not attainable but at an enormous price.

In many cases, it is common after raising this wall to the wished for height, to level the top of it with loose stones, and leave it in that situation, without any coping or other security. The consequence is, what might naturally be expected, the first person who attempts to climb over it, or the first horse or bullock that puts its head over the top, or attemps to rub itself against it, infallibly throws down a part of the stones, and in that way the fence is gradually destroyed. Whereas, when a substantial coping of stone and lime is given, the wall is so completely bound together and consolidated at top, as to bid defiance to any common injury. The copings of turf and mud, so common in many places, are by no means entitled to approbation; for though they may for a short time secure the top of the building, they soon decay, and cannot be procured, but by paring and cutting off the adjoining surface: for these reasons, turf, or mud copings are improper, even upon dry stone walls, upon those made with stone and lime, or stone or clay, as we shall afterwards have occasion to notice, they are totally inadmissible.

Stone and Lime Walls, &c.—To render stone and lime walls durable, they should be constructed in the manner above described, for dry stone walls; that is, have a good foundation, deep enough to prevent them from being hurt by frost, with a broad base, tapering gradually upwards.

* It is customary in some parts of England to plant ivy both upon their dry stone walls, and upon such as are constructed with stone and clay. This has a good effect, not only in point of appearance, but after a while, it binds and strengthens them very considerably; there are several kinds of ivy, *viz.* the large and the small leaved, the dark green and the variegated, all of which look well; those kinds, however, should have a preference that grow fastest, and have the greatest tendency to ascend. Particular care should be taken not to plant ivy in the immediate neighbourhood of young trees, or hedges, as, next to moss, nothing can be more destructive to trees or hedge plants..

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This fence, when properly executed, is (next to hedges) the most durable of any; it is, however, very expensive, and its superiority over the dry stone wall is so trifling in point of durability, as to render the latter the most eligible, it being greatly cheaper, and answering every purpose of a fence equally well.

For the building of this wall, stones taken from the quarry are to be preferred to the common land-stones; for though a mason may be able to remedy, in some measure, the inequality of surface in land-stones, by mixing plenty of lime with them, yet experience proves, that walls made with such stones, nothwithstanding every care on the part of the builder, are much less perfect, and last much shorter time, than where quarried stones are employed.

This, like every other stone fence, should be secured at the top with a substantial coping of stone and lime; the best and most durable is that which is made with stones of the flag kind, laid together in the form here represented; Λ the space between them being filled with a mixture of small stones and mortar. This coping, from its wedge-like shape, and the solid impenetrable surface which it presents to the weather, seems the best calculated of any, for the preservation of the building. When a stone and lime wall is left without a coping, which is too often the case, the moisture finds its way readily into the heart of it; it is, besides, liable to all those accidents already mentioned, in speaking of dry stone walls, when they are left without a coping.

When stone and lime walls are built, the season of the year at which the work is done, is none of the least important considerations; for if they are erected either at a late period of the autumn, during the winter, or very early in the spring, the frost acting upon the moisture contained in the lime, will separate, and disunite its parts, and by that means destroy the cohesion of the building; the binding power of the lime, in such cases, is entirely lost, and when summer arrives, it resembles dry sand, mixed with the stones.

Late in the spring, during the summer, or early in autumn, seems to be the most proper time for building stone and lime walls; at any, or all of these periods, there is every prospect of the lime drying properly, and not the smallest risk of its binding quality being hurt by the effects of frost.*

* In speaking of the binding powers of lime, the Author of this Paper begs leave to mention a cir-circumstance, which seems entitled to the notice of those who are erecting buildings upon the sea coast. The Rt. Hon. the Earl of Wymess, in completing a line of inclosure upon his estates on the south side

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Galloway Dike (Pl. V. fig. 36.)—The Galloway dike, as has been already noticed owes its name to the circumstance of its being first used as a fence in that country. It is now, however, very common in most parts of Scotland, and in some of the English counties. It is principally employed for inclosing high grounds that are depastured with sheep, for the confining of which, it seems well calculated.

From two feet, to two and a half, at the bottom, it is built in a regular compact manner with dry stones, in every respect the same as a dry stone wall, with a broad base tapering gradually upwards; the building is then levelled with a course of flat stones, resembling a coping, in such a manner as that these flags or flat stones shall project two or three inches over the wall on each side. Above these flat stones is laid a course of rugged round ones, placed upon each other in a way secure enough to give stability to the building, but at the same time so open as to leave a considerable vacuity between each; by which means a free passage is afforded to the *light* and *wind*, which blows through them with a violent whistling noise.

This rough open part of the building is generally raised three feet above the regular part of it, gradually tapering upwards, till it terminates in a top of about nine inches broad, every course of the rough stones being smaller than that immediately beneath it. Its tottering appearance is so well calculated to prevent sheep, cattle, or other animals from approaching it, that it is seldom, indeed, that any attempt is made to leap over it. This circumstance, together with the ease with which the stones are procured, in most of the situations where the Galloway dike is used, renders it a valuable fence.

The expence of erecting it will be very different in different situations, according to the ease or difficulty of procuring stones, the price of labour in the country, and other circumstances. In many cases where the fields to be inclosed are infested with large stones, the removal of which ought always to be a previous step in every plan of improvement, the inclosure may be made for a trifle, merely for the expence of masonwork. In no instance can it be dear; and in most situations, where the confinement of the stock, or the partition of a crop are the sole objects, this will be found to answer the purpose equally well, if not better than more expensive fences.

It has, however, one defect, in common with all other stone fences, *viz.* that it

of the Frith of Forth, was under the necessity of using salt water not only for slacking the lime, but for bringing it to the consistence of mortar, after it was mixed with sand. Contrary to all expectation, the work done with the salt water took band sooner than what was done with fresh water, and continues firm and solid. This circumstance was communicated to the Author by the Earl of Wymess.

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neither shelters nor ornaments the country; indeed, in point of shelter it is the most defective of any, for compact stone walls of a proper height are capable of affording considerable shelter to the grazing stock in stormy inclement weather, an advantage which cannot possibly be expected from the Galloway dike, on account of its openness. On that account it appears much more eligible for the lower parts of the country where the land is valuable, where little shelter is required, and where the confinement of the stock, or the protection of a crop, are the sole objects.

The advantages of stone fences of every description are very considerable; they not only form complete inclosures at once, and by that means allow the proprietor to enter into immediate possession of every advantage, that can arise from the inclosing of his fields; but, by the little room they occupy, a considerable portion of land is saved that would have been occupied by some other fences: and even that proportion of soil near the sides of stone walls, which is at present for the most part waste, admits of being profitably employed, either in raising grain, potatoes, or other vegetables; and the walls, as we have already observed, may be usefully employed in rearing of fruit trees, or the different kinds of currants, gooseberries, &c. &c.

To these benefits we have, however, to oppose some defects. The best and most substantial fences of that description are perishable in a greater or less degree, according to the materials of which they are made, and the judgment shewn in their construction; and after a certain time, require considerable attention, and expence to keep them in repair; the shelter they afford to the *stock*, crop, or pasture, is also small, and in place of improving the scenery, they hurt the general appearance of the country.

Walls of Stone and Clay.—In the construction of this fence, the clay is used like lime, and is meant to answer the same purpose. It requires slender observation to convince intelligent persons, that a wall made with such materials in the ordinary way cannot be a durable one; for if the clay made use of in building the fence has been very moist, the summer's heat will dry it so much, as to leave considerable chasms in the building; these chasms must nesessarily deprive many of the stones of that support which they require, and in that way, endanger the building. This, however, is not the only inconvenience with which this kind of wall is attended; the effect of the summer's sun upon the clay parches it so completely, that when the wet weather commences about the end of autumn, it absorbs the moisture like a sponge, and if it is overtaken by frost while in that state, the fabric *swells*, *bursts*, and tumbles down.

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With the very best coping than can be given it, stone and clay walls must always be considered as a very exceptionable fence, as, however well it may be defended at top, the moisture will penetrate at the sides: if it is left without a cope, however, or is only coped with mud or sod, the evil will be greater, as the moisture will in that case find a ready passage downwards, and in that way accelerate the destruction of the wall.

Walls of Stone and Clay, dashed with Lime.—This fence differs in no respect from that just now described, except in the harling, or dashing that is given it: where that operation is well performed, and at a proper season of the year, the coating of lime, by preventing the entrance of moisture, will add greatly to the durability, as well as beauty of the wall; so much so indeed, that some fences made in this way, where the clay was properly tempered, and did not contain too much moisture, and where a harling or dashing of lime was afterwards given, have been known to last nearly as long as walls made entirely with stone and lime. The durability of this, as well as the foregoing fences, depends upon its being properly coped.

Dry Stone Walls, lipped with Lime.—This fence differs from the ordinary dry stone wall, in having about two or three inches of it on each side lipped with lime, which gives it the appearance of being built entirely with stone and lime. Where the external appearance of a fence is an object, something is gained by this practice; in point of real last, however, it seems to possess very little advantage, over the common dry stone wall, which, when properly executed, lasts as long as that, we have just described.

Dry Stone Walls, lipped and harled.—This consists in nothing more than a harling or dashing of lime after the other work is finished; this addition is to be considered merely as an improvement upon its appearance, and not as contributing to increase its utility, or render it a more durable fence.

Dry Stone Walls, pinned and harled.—This consists in first building a common dry stone wall, which, when it is finished, the mason carefully pins or fills up all the interstices of the building with small stones, and afterwards dashes or harls it over with lime. The pinning, by filling up every vacant space, and affording complete support to the stones, in every part of their surface, adds considerably to the durability of the building, and the harling afterwards gives the whole a finished substantial appearance, which renders it at once agreeable to the eye, and durable as a fence.

Dry Stone Wall, with a Paling upon the Top (Pl. XI. fig. 62).—Low stone walls are sometimes made with a light paling upon the top, and for particular purposes answer well, and have a handsome appearance.

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Brick Walls (Pl. V. fig. 37; Pl. XI. fig. 61, and 62.)—Brick walls are seldom had recocourse to for ordinary inclosures, except in situations where stones are extremely scarce, as is the case, in many of the English counties, for pleasure-grounds, or for garden walls.

Brick walls are of two kinds; the first consists of bricks only, and are built either with the brick *on edge, in bed,* or *across.* Where the wall is built with bricks on edge, they are laid up with the edge or narrowest part of each applied to the other; the thickness of the brick in such a case constitutes the thickness of the wall. Where brick in bed is used, the bricks are laid flat, and the thickness of the wall is proportioned to the greatest breadth of the brick. When they are laid across, the thickness of the wall is then equal to the length of the brick.

In all of these cases, it is common to have a frame of wood of the height of the wall, with proper standards and supports at regular distances, which not only serve as an infallible direction to the builder, but also strengthen the wall very considerably. The benefit derived from these wooden frames is, however, only of a temporary nature, as that part of them which is let into the earth soon rots, and the building, by being deprived of its support, falls in consequence.

The most valuable use to which bricks are applied, is either for facing walls built with coarse stones, for gardens, or for heightening old stone walls: for the first purpose, they are an excellent article, and any wall fronted with brick is, for the purpose of rearing fruit trees, of equal value with one of the most expensive hewn stone.

Where it is intended to beighten a stone wall that is to slender too bear a heightening of stone, bricks either in bed, or on hedge, will answer the purpose very effectually, without rendering the wall *top-beavy.*

It is to be noticed, however, that in every case, either where a wall is made entirely of brick, or heightened with it, there will be a necessity for strengthening it at the back with pillars at certain distances from eacb other, as represented in Pl. XI. fig. 61, 62; these will add to the stability of the building, and if properly executed, will render it equally durable with a stone wall.

For hot-walls, they are very valuable, as they not only, by their numerous seams, allow the trees to be regularly and neatly trained, but are at the same time extremely convenient for shaping the flues that conduct the heat.

Where the price of labour is low, and clay of a proper quality, together with fuel, can be easily obtained, bricks may be used with advantage for almost any purpose

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where stone is at present employed; we believe, however, that their use will be chiefly confined to the facing of garden walls, to the walls of hot-houses, to hot-walls, or the heightening of old stone walls; in all of which, they will be very valuable, and will, at a small expence, answer the same purpose as hewen stone.

Brick walls are variously coped; in some cases they are coped with the common brick, set up in such a way as to form an angle upon the top; in others they are coped with a sort of tiles resembling the letter A, flat below and angular above, with a border projecting a little over the wall on each side. In different parts of England this coping is used for brick walls, and is found to answer the purpose very effectually; in some instances, however, the coping is entirely flat, which is disapproved of, on account of its not affording so ready a descent to the moisture.

Frame Walls.—This fence is not generally known by the name here given it. In the East Lothing Report it is termed (with what propriety we cannot discover) A STONE PALING. It is constructed in the following manner: a frame of deal boards, of a width and heighth proportioned to that of the intended fence, is placed upon the line in which it is intended to be made, a proper foundation having been previously dug; the frame is then filled with stones of all sorts, gathered principally from the adjoining fields; when the frame is filled to the top with such stones,a quantity of *liquid mortar* is poured in amongst them, sufficient to fill up every interstice; the whole is suffered to remain in that state till it is supposed that the mortar has acquired a suitable degree of firmness to give stability to the building, which in summer, when the weather is warm and dry, will not require above a day or two. The frame is then removed, and placed a little farther on in the same line, in such a manner as that one end of it shall join immediately with that part of the work from which it had been removed. In that way the line of fence is gradually completed, which, when the lime has been well tempered, and the proper pains taken to incorporate it with the stones, presents a smooth uniform surface, and has a firm substantial appearance.

There remains now very little doubt, that the durability of many of the ancient buildings was owing in a great measure, if not entirely, to their following this mode; as it is observed in taking down several of them, that the outside of the wall only, is faced with large flat hewed stones, which serve as a kind of plating or frame to the building, while the inside or middle consists of very small stones, and in not a few cases, of round well washed gravel, cemented together by pouring liquid mortar amongst it.

Turf Walls. (Pl. V. fig. 38.)—In almost every upland or hilly district throughout

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Britain this fence is met with, and for temporary purposes is found very useful. In a variety of instances it is used for inclosing the fields, and is practised for that purpose to a very considerable extent; in others, however, it is used for the formation of folds, pens, or other places of confinement for cattle during the night. In general the fence is made with turf only, pared off from the adjoining surface, and used without any mixture of earth; in others cases, the wall consists of a facing of turf on each side, while the space between is filled up with loose earth.

For a fold, or any other temporary purpose, this fence answers extremely well; but for inclosing a field, or indeed any other use where durability is required, it should never be had recourse to, as from the moment it is finished, its decay commences, and no pains nor attention will be able to keep it in repair after it has stood two or three years. In very exposed situations, however, it may be useful as a protection for young hedges, during the first three or four years of their growth; but as a wall of this kind, can in no instance be made without a destruction of the adjoining surface, which upon good lands is a serious loss; the protection of young hedges will be answered equally well, by low stone dikes, which, while they perfect the inclosure, will at the same time shelter the young plants, and clear the field of a nuisance.

Stone and Turf Walls. (Pl. V. fig. 39.)—This fence is very common in many situations, where a better and more durable one could be made at equal, perhaps less expence. In many instances, however, it is had recourse to, from necessity, where lime is either very dear, or not attainable at any price. The stones used in the construction of this fence, are in general the ordinary land stones; with these, and the turf taken from the adjoining surface, the wall is made, using alternate layers of each. For temporary purposes this fence may be adopted in almost every situation, as it is reared at small expence, and the materials are every where to be met with, almost without trouble: but in all cases where permanent fences are wanted, this will be found very deficient, even to the common turf wall, for by the intervention of stones between every layer of turf, the sod is dried, the plants die, the turf as might naturally be expected soon decays, and the wall crumbles down; whereas, when it is built entirely of turf, with a sloping bank of earth behind, the herbage continues growing, and the whole turf of which the wall is made, soon consolidates into a uniform green sod, which with proper care will last for many years.

Mud Walls, with a Mixture of Straw. (Pl. V. fig. 40.)—Walls of this kind are very frequent in many parts of England, not only for surrounding their small

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inclosures and stackyards; but also for constructing the walls of many of their farm houses and offices. In North Britain, they are used for similar purposes, and for sub-dividing houses into different apartments; for which purpose they answer equally well as lath and plaster, and last nearly as long.

When either the outside walls, or the inside divisions of a house are made of these materials, the custom is, to take a small quantity of straw, and incorporate it with a sufficient proportion of clay; the straw in this case, answers the same purpose as hair in *plaster lime*. When a sufficient number of these are made, the work is begun by laying a stratum at the bottom of the intended wall; when this is done, and the different pieces firmly kneaded, or wrought together with the hand, a flat deal board is applied on each side, which being properly pressed, and rubbed against the building in a horizontal direction, not only serves to consolidate the work, but gives it a degree of smoothness and uniformity; successive stratums are added, till the wall is raised to the intended height, taking care to taper it gradually upwards. Walls made in this way, if properly constructed, will last for many years, and if dashed or harled with lime, at a proper season of the year, will have an appearance no way inferior to such as are made with stone and lime, along with this addition to their appearance, the harling or dashing with lime, if properly done, will, by preventing the access of moisture, render them much more durable.

When walls of mud and straw are to be made, pieces of wood properly joined and secured, should be set up in the direction in which the fence is to run. These should be in the form of a double paling (as represented in Pl. VI. fig. 41.), and calculated to answer the same purpose as the standards employed in making brick divisions in a dwelling house; the upright parts should be placed in such a manner, as to be immediately opposite to each other (as represented in Pl. VI. fig. 41.), and placed at a distance equal to the thickness of the intended wall. These standards will not only render the fence firmer, and more durable, but will at the same time serve as a direction to the workmen, in keeping it of a regular thickness and shape.

In England, where stones are scarce, and in many of the counties not to be had, walls of this description are the *sine qua non*, for many purposes, and when properly constructed, last a considerable time; but in every instance where stones are procurable at a reasonable price, a fence made with them, is greatly to be preferred; as it is in general built with less trouble and expence, and is at the same time much more durable. At best it is, however, of a very perishable nature, and the great

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expence that is required to keep up such fences, has long since taught both proprietors and occupiers, that they are by much the most expensive of any.

Compound Fences.—By compound fences are to be understood, all those in which any two or more of the simple fences are combined; the following list comprehends the whole, or the greatest part of these.

1st. Hedge and ditch, with or without paling.
2d. Double ditto, with or without ditto.
3d. Hedge and bank.
4th. Hedge in the face of a bank.
5th. Hedge on the top a of bank.
6th. Devonshire fence.
7th. Hedge with single or double paling.
8th. Hedge and dead hedge.
9th. Hedge and wall.
10th. Hedge, ditch, and wall.
11th. Hedge in the middle of a wall.
12th. Hedge and ditch, with row of trees.
13th. Hedge and belt of planting.
14th. Hedge, with the corners planted.
15th. Reed fence, or post and rail covered with reeds.

1st. *Single Hedge and Ditch, with, or without Paling.*—To those who are acquainted with this kind of fence, a description of it may appear superfluous. The ditch is of different dimensions, according to circumstances; the thorns are for the most part placed upon the common surface, upon what is termed a scarcement, or projection of six or seven inches, on which they lean, and which serves as a kind of bed, when they are cleaned. By placing the plants thus far back, from the edge of the ditch, they are in a great measure secured against the accidents to which they would otherwise be liable, if they were placed immediately in the front of the bank: as there are few ditches, however carefully they may have been made, into which the earth does not afterwards slide, and fall in.

In cases, therefore, where the thorns are planted immediately *in the face*, or what is termed the *brow* of the ditch; if any portion of the earth falls in, it either carries the plants along with it, or deprives them of their nourishment; whereas, by placing

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them at the distance of six or eight inches back from the front, there is no risk whatever, of their being injured by the earth falling in.

It appears that the space commonly allowed for a scarcement, is by far too little, being seldom more than four inches. In place of which, it ought never to be less than twelve or fourteen inches. This would have several advantages, as it would not only prevent all risk of the earth tumbling in, and bringing the plants along with it, but would at the same time afford ample room for weeding the hedge completely, and drawing up the earth, to the roots of the plants. These are matters of considerable importance, and which, along with their destroying weeds, promote the growth of the hedge, by affording sufficient pasture for the plants, and enabling them to resist the effects of drought frost, &c. much more completely than they would otherwise have been able to do, if planted immediately in *the face of the ditch.*

It is common to lay the hedge plants upon the plane surface, without any preparation whatever. In other cases, the first spadeful that is taken out of the ditch, is laid on the front, and the plants placed above it; whatever the soil or situation may be, it is of high importance to place the plants upon a bed of good rich well prepared earth, capable of affording them not only a due degree of nourishment; but into which their roots may strike with the utmost ease. Upon a very dry soil, and in elevated situations, it is sometimes necessary to place the hedge plants, considerably below the common surface, to prevent them from suffering by drought; where this is practised, the ditch is first dug of the ordinary dimensions, and the earth that is taken out of it laid about 20 inches back from the edge; the labourer then, with a spade, cuts down a space, about fifteen inches broad, and ten or twelve inches deep, along the whole front of the ditch; this space when cut resembles a shelf; an inch or two of the best mould, well broke and pulverized with the spade, is laid upon this shelf or scarcement, upon which the plants are laid, not exactly in a horizontal direction, but with the top a few degrees higher than the roots. The earth taken out in forming the shelf, is then replaced above the roots, in such a manner as to form a good slope, from the front of the ditch backwards.

Where the soil is deep enough to admit of this being properly done, there are few situations, however dry, where the hedge will run any risk of suffering from drought.

In very cold wet situations, this practice is reversed; and in place of planting the hedge upon, or below the common surface, it is found necessary to raise it considerably

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higher; for that purpose the first two spadings taken out of the ditch, and which always consists of the best earth, are laid about ten inches back from the front; this, when properly done, forms a bed, of from twelve to fifteen inches in thickness, upon which the plants are laid; the roots are then covered with the remainder of the best earth, and the bank formed in the ordinary way. Where the hedge is either *white thorn*, *crab*, or *beech*, the precaution of raising it above the common surface, is essential to its welfare upon cold or wet soils: and in many of these situations, good hedges are made in that way, that could not possibly have been done by any other means. It must be admitted, however, that by raising it so much above the common surface, the pasture of the plants is in a great measure confined to the bank, formed by the earth taken out of the ditch; and in many instances, when the winters are severe, and much black frost happens, it penetrates the bank so completely, as entirely to destroy the hedge.

In all cases where hedges are to be made either in this, or any other way, the soil, as far as circumstances will admit, ought to be *cleaned*, *pulverized*, and *enriched* with *lime*, *compost*, or other *manures*; which will not only enable it to push away vigourously, but at the same time prevent, in a great measure, the distempers of moss or cankering, to which hedges upon stiff clays or cold wet soils are so liable.

In speaking of the simple ditch, notice has been taken of the necessity of giving it a proper slope, to prevent its tumbling in after frost, or being excavated by the run of the water. Where a hedge is added to the ditch, this precaution is equally essential, indeed more so, as the injury done to a simple ditch, can be repaired with the spade at little or no expence; whereas, when a hedge is planted in the front, any considerable portion of the earth falling down, brings the plants along with it, and makes a breach in the hedge, which no industry will afterwards be able to cure. To keep them pretty broad at top, and gradually tapering towards a point at bottom, ought to be a constant and invariable rule: ditches so constructed are seldom, if ever undermined, and retain their shape for many years. Upon ditches so formed, from their containing little water at bottom, the greatest pressure and action of the fluid is upon the upper part, and upon that, from the nature of the slope, its effects are lost. Those who have made sufficient observations, know, that in every instance where water acts upon a perpendicular surface (especially if the soil is of a soft incoherent nature), its force is greatest; whereas, when it operates upon a sloping bank, its face is short, and it does no injury. A knowledge of the laws of hydrostatics explains this. The pressure and

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operation of fluids, is always in proportion to their altitude or perpendicular height. Upon a sloping bank this pressure is lost; and the more gradual the slope, the less effect the water has. It is owing to this circumstance, that the low sloping parts, both upon the banks of rivers, and on the sea coast, continue unaltered for many ages, while the high bold parts of the shore, unless they are entirely of rock, are continually tumbling down.

The same thing holds good in regard to ditches: whatever the height of the column of water may be in the middle, or however rapid the current, the narrowness of the ditch at bottom, and its sloping gradually upwards, divides and diminishes the force so completely, that it is scarce felt upon any part of it; whereas, when the ditch is *wall-sided*, and of one uniform width from top to bottom, the water, by being confined almost intirely to the under part, runs away the soil, and excavates and undermines the sides of the ditch, which occasions their falling in.

In cases where the purposes of the proprietor or occupier require, that the fields recently inclosed with ditch and hedge should be made fencible at once, it is very common either to surround them with a paling placed upon the top of the bank formed by the earth taken out of the ditch, or with a wall of coarse loose stones, in the form of a Galloway dike, placed also upon the top of the bank. Pl. VI. fig. 43, represents a young hedge protected with an open wall of this sort. Where stones are plenty, this last forms an excellent fence for the purpose of confining the cattle, and is at the same time a good shelter for the hedge.

When a paling is placed upon the top of the bank, it is made of different materials, according to the circumstances of the case; in some situations it is made of slabs, in others of laths, the prunings of fir plantations, &c. in all of which, when properly executed, it not only answers the purpose of a temporary fence, but at the same time serves as a complete protection to the young hedge from the depredations of sheep, cattle, &c.

Double Ditch and Hedge (Pl. I. fig. 2.).—In speaking of the double ditch as a simple fence; its use, and the various situations in which it is applicable, whether as a fence, or an open drain, have been noticed at some length. To what was there mentioned, we have now to add, that the custom of inclosing with double ditches, and a hedge in front of each, is now practiced in many parts of Britain, especially upon what are termed cold lands; from an idea, that a single row of plants would not grow sufficiently strong or thick, to form a proper fence. The advocates for this fence farther allege, that along with the two rows of plants forming a more sufficient fence,

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an opportunity is afforded, of planting a row or rows of trees on the middle of the bank, as represented in Pl. XI. fig. 64; we shall afterwards have occasion to notice this last as a very exceptionable practice.

The double ditch and hedge is liable to many objections; the expence of forming the ditches, the hedge plants made use of, and the ground occupied thereby, being double of what is requisite, in a single ditch and hedge. From 12 to 18 or 20 feet is the least that is required for a double ditch and hedge; this space, in the circumference of a large field, is so considerable, that upon a farm of 500 acres, divided into 15 inclosures, the fences alone will occupy above 40 acres. By throwing up a bank in the middle, the whole of the nourishment not only of both hedges, but also of the row of trees, is confined solely to that space, which, from its being insulated by the ditches, and elevated so much above the common surface, not only curtails the nourishment of the hedges and row of trees, but exposes them to all the injuries arising from drought, frost, &c. &c.

The idea of two rows of plants making a better hedge than one, is certainly no good reason, for such an unnecessary waste of land and money; as in almost every instance, where the plants are properly adapted to the soil and climate, one row will be found quite sufficient; but if it should be preferred to have two rows, which, we repeat, will for the most part be found unnecessary, the purpose will be answered equally well with a single ditch, or even without any ditch at all; for in every situation where the soil is tolerably dry, and the fields much elevated above the level of the sea, the ditch, except for the purposes of drainage, may be dispensed with. In addition to the double ditch, and while the hedges are still young, the fence is sometimes strengthened by a paling, either of young firs or other wood placed upon the top of the bank; in other cases, a dead hedge is planted in the middle between the two quick-hedges, and not unfrequently, an open wall resembling a Galloway dike, made with round stones, is placed in the same situation; any of which, when properly executed, not only inclose the field completely for the time, but also very effectually shelter the young plants.

The great expence, the waste of land, and the little superiority which this fence possesses over the single hedge and ditch, are sufficient reasons for laying it aside. The argument used by many, of two ditches holding more water than one, and of course rendering the field so inclosed, drier, is unworthy of attention. The purpose of ditches, when properly understood, is not to retain, but to carry off water; and their chief benefit depends upon their being so constructed as to answer this last purpose completely;

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a ditch must be large indeed, that is capable of containing the whole of the water running from a large field.

Hedge and Bank (Pl. I. fig. 3).—This fence consists of a hedge planted upon the plain surface, with a bank or mound of earth raised behind it, by way of protection. A very good idea of this fence may be formed from the above figure. This bank in some instances is faced with sod on both sides, sloping gradually towards the top; while in others, and indeed by far the greatest number, it is only faced on one side, which is nearly perpendicular, and has a gradual slope on the other, similar to the bank made with the earth, taken out of an ordinary ditch. The hedge is frequently planted at the bottom of the perpendicular side, that is faced with sod; but in many cases, it is planted on the other side, near the bottom of the sloping bank of earth. The last is certainly the best situation for the hedge; for if the earth with which the bank is made, has been taken as it generally is, from the side that is faced with sod, this facing will form a kind of sunk fence, the bottom of which will be considerably below the common surface; of course, any hedge planted in such a situation, will not only be put into the worst of the soil, but will at the same time be in danger of perishing from the moisture lodging there, and chilling the roots; whereas, when it is planted on the other side, near the bottom of the slope, the plants have the best of the soil to strike into, and are in a great measure secured against the bad effects of moisture lodging and chilling their roots.

In bleak exposed situations, where hedges cannot be successfully reared without shelter of some kind or other, the bank of earth is a good contrivance, as it screens the young plants from the inclemency of the weather, till they acquire a degree of strength sufficient to enable them to resist the rigour of the climate, which it is now well known, many plants are able to do after they arrive at a certain age and strength, that would have been completely killed, had they been exposed in the same situation, and without shelter, at an earlier period.

In such cases, therefore, earthen mounds similar to what we have described, or stone walls, are essential to the rearing of good hedges, especially of white thorn.

This fence, like the common turf wall, cannot be erected without a considerable destruction of the adjoining surface; on that account, it should never be used but in cases of the strongest necessity. The only instance in which it can be made without any loss, is upon the sides of highways, as represented in Pl. I. fig. 4, where the road is not bounded by a ditch, but slopes gently to each side; in that case a sufficiency

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of turf and earth, for facing and forming the bank, may be had from the side of the road. This will have a double advantage; the earth, if taken from the road with judgment, and in such a way as to form a gradual slope from the middle towards the sides, will produce two very considerable advantages; the slope will keep the road perfectly dry, and the earth taken from it will, with the assistance of a slight paling, completely inclose the field, and serve as a protection to the young hedge.

It is worthy of remark, that when the hedge is planted behind the bank, the paling should not be upon the top, as is commonly the case, but on the side next the field, to serve as a protection against the cattle grazing in it; when it is next the road, however, the paling may be placed upon the top, in which case it will render the fence more inaccessible.

Hedge in the Face of a Bank (Pl. VI. fig. 44.).—This fence differs from the former, principally, in having the hedge in the front of the bank considerably above the common surface, in place of having it at the bottom, as already described. The work is executed in the following manner: the bank faced with sod on one side, and having a gradual slope on the other, is raised to the height of 18 inches, or two feet; the top is then levelled, and covered with two inches of good earth, above which the plants are laid horizontally, with their tops projecting about a couple of inches over the edge of the bank; the roots are afterwards covered with the same mould, and the bank raised to the desired height. This fence is greatly inferior to that already described, as the hedge plants, by being raised so much above the common surface, are liable to great injury, not only from the bank decaying and mouldering down, and by that means depriving them of their nourishment and support, but also from the effects of frost, drought, &c. &c. In many instances, however, it may be useful, especially in the inclosing of wet lands, where hedges would not thrive, if placed upon the common surface; but in such cases, it is worth while to notice, that great advantage will arise, from placing the hedge plants about eight or ten inches back from the front, upon a sort of scarcement similar to what is done in the common ditches. When planted in this way, there is little, indeed no risk of the bank mouldering down; and the shelf or scarcement left, admits of the hedge being completely cleaned, and the earth drawn up to the roots of the plants; circumstances essentially necessary to the future welfare of the hedge.

Pl. VI. fig. 45, represents another description of hedge and bank, which is met with principally, by the sides of highways, in situations where the ground has a sudden

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declivity towards the road; in these cases, it is common to cut down the face of the bank in a sloping direction, to within 18 or 20 inches of the bottom, where a bed is made of about two feet broad, covered with good earth broke very small; upon this the plants are laid, with their extremities about 9 inches from the front; the roots are then covered with eight or nine inches of good mould; the bed below with the projection in this case, serve the same purpose as the scarcement of the common ditch, and affords complete room for cleaning, and drawing up the earth to the roots of the hedge.

In the construction of this fence, it is essential to give the face of the bank such a slope, as to prevent the earth from tumbling down; if this is neglected, it will be continually falling in large masses after every frost, or fall of snow or rain.

It is sometimes the practice, however, instead of planting the hedge within 18 inches of the bottom, as here described, to slope the bank first, in such a way as to insure it against tumbling down, and plant the hedge upon the top, at the distance of about a foot and a half from the verge of the bank. A hedge planted in this way, when it thrives, will certainly look much more formidable than one planted at the bottom; but it will be liable to more accidents than the other, from drought, frost, and the falling in of the bank. Upon this subject more will be said, when we come to speak of the hedge upon the top of the wall.

Hedge and Bank, or Hedge on the Top of a Bank (Pl. VI. fig. 46.).—This fence is common in many parts of England, and also in some parts of Scotland, and consists of a high bank of earth taken from the adjoining ground, pretty broad at bottom, and tapering gradually towards the top, upon which the hedge is planted.

From the opinions and observations of the most intelligent persons who have communicated with the Board, this appears a very objectionable fence. It has already been noticed, in speaking of hedge and bank, that the surface of a great part of the adjoining ground is pared off, and in that way a theft is committed upon the soil, which cannot be easily repaired; and even after the bank is formed, it is incapable of retaining a sufficiency of moisture, to nourish the plants during summer, and in severe winters, the frost penetrates the bank so completely on all sides, and acts so forcibly on the roots of the plants, as sometimes to kill a whole hedge at once. This misfortune happens very often to old strong thorn hedges, but more especially to whin hedges, many of which, after the severe winter of 1794-5, were completely killed for miles together. In the neighbourhood of Lawrence Kirk, on the great post-road leading to Aberdeen,

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many fields which were completely inclosed by whin hedges, before the winter set in, were in the spring laid quite open by the total destruction of the fence.

But allowing this fence to be exempted from the bad effects both of frost and drought, there remains one circumstance to be mentioned, which of itself is sufficient to bring it into disrepute. Turf or earth taken from the common surface, when put into a bank, and raised so much above the situation in which it originally was, becomes unfit to nourish, or support the herbage which formerly grew upon it: in that way the plants die; their place is supplied by a species of moss, which is well known to be very unfriendly to the growth both of hedges and trees, not only by rendering the soil loose and incoherent, and thereby subjecting the plants to every injury that can arise either from frost or drought, but also by covering their bark; a circumstance which, when it once takes place, is, unless great care is taken, ultimately fatal to them.

It is deplorable to see the wretched situation of many fences, both in England and Scotland, from that cause alone, which, in place of having many vigorous shoots, abounding with numerous lateral branches, consist only of naked stumps, covered with moss. This disease upon certain soils, as has been already noticed, attacks even hedges planted upon the common surface, but where the hedge is placed upon the top of a bank, it is liable to it, upon every description of soil.

Devonshire Fence (Pl. VI. fig. 47).—The Devonshire fence consists of an earthen mound, seven feet wide at bottom, five feet in height, and four feet broad at top, upon the middle of which, a row of quicks is planted, and on each side, at two feet distance, a row of willow stakes, of about an inch in diameter each, and from eighteen inches to two feet long, are stuck in sloping a little outwards; these stakes soon take root, and form a kind of live fence, for the preservation of the quicks in the middle.

The Devonshire fence so nearly resembles the hedge on the top of a bank, that any additional observation upon it may perhaps appear superfluous. It is equally expensive in the erection; the formation of the bank deprives the adjoining surface of its best soil, and the plants made use of, are liable to every injury that can possibly arise from drought, frost, and the gradual decay or crumbling down of the mound. The addition of the willows to this fence, is certainly a disadvantage; if the quicks require protection, dead wood is equal to every purpose that could be wished or expected; and at the same time possesses the additional advantage of requiring no nourishment, and having no foliage to shade the quicks.

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Hedge with Post and Rails (Pl. VI. fig. 48.).—Palings are frequently employed for the protection of hedges, as well those, that are planted upon the plain surface, as for the hedge and ditch united.

The addition of a paling becomes more immediately necessary, in cases where the hedge is planted upon the plain surface, especially when the fields so inclosed, are in pasture. If only one field is inclosed in this way, and the adjacent lands are under a corn crop, a single paling on the inside of the inclosed field will be quite sufficient for its protection; but when the adjacent fields are also under pasture, a double paling becomes necessary, or, in other words, a paling placed on each side of the young hedge, at a sufficient distance to prevent the sheep or cattle from cropping it; without such protection the hedge plants are not only liable to cropping, but also to being trodden and destroyed by their feet, an injury which, when it happens at an early period of their growth, the plants continue low and stunted ever after.

Hedge and Dead Hedge (Pl. VII. fig. 49.).—This fence consists of a row of quicks or other hedge plants, set either upon the plain surface, or in the face of a ditch or bank. The dead hedge answers a double purpose, namely, that of protecting the young plants from the injuries they may receive from cattle, or the inclemency of the weather; and, at the same time, forming a temporary inclosure, which lasts till the hedge is grown up. Where dead hedges are made of proper materials, such as the cuttings of thorn hedges, &c. and are well let into the ground, they answer these purposes very completely, and should always be used for the protection of young hedges, where the materials can be obtained at an easy rate. It is worthy of notice, however, that in every instance where dead hedges are used for the protection of live ones, in place of cramming them close together, as is commonly done, there should be a distance of least three feet between them. In that way the hedge plants will have room to grow and spread out their lateral branches at bottom, a thing essentially requisite to the formation of a good hedge, while an opportunity will at the same time be afforded of weeding the hedge, and loosening the earth completely on both sides of it.

Hedge and Wall (Pl. VII. fig. 50.).—This fence is of two kinds, one of which has been already described, namely, where a coarse open wall, made of loose stones, and resembling a Galloway dike, is made upon the top of the bank, formed by the earth taken out of the ditch. The second is chiefly used when hedges are planted upon the plain surface; in which case the wall, though thin and low, is regularly built, and

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answers the double purpose of sheltering and encouraging the growth of the plants, while they are in a weak tender state, and afterwards prevent the possibility of the hedge becoming open below, where gardens are entirely, or in part surrounded by hedges, and in the inclosing of fields by the sides of highways, especially in the vicinity of great towns, where dogs and other destructive vermine are apt to creep into the inclosures, and annoy the stock; the low wall forms a valuable addition to the fence.

It is customary in some cases, after the hedge has attained a certain height, and is thought to be out of danger, either to remove the wall entirely, or allow it to decay. This is certainly a bad practice; as it not only leaves the bottom of the hedge naked and open, but at the same time deprives the roots of the plants of a protection to which they have long been accustomed, and the removal of which operates, as a severe check to their growth. In every instance where the wall is intended to be removed, care should be taken to cover the roots of the plants, that are left exposed, with good earth; by that means they will be prevented from being hurt by exposure to the weather, and they will suffer little, if any, check. It frequently happens, however, to the utter disgrace of the proprietor, that the wall is removed, and the roots of the plants left naked, and exposed to every injury. In such cases, if the hedge has been planted a little above the common surface, as soon as the wall is removed, the earth begins to moulder and fall down, and continues to do so till the plants deprived of their support, tumble down also, and the hedge is by that means entirely ruined.

There is another description of hedge and wall, which properly comes under consideration in this place: that is, when the hedge is planted upon the top of the wall: this differs from a hedge on the top of a bank, already described, only in one particular, which is, that of the bank being faced with stones, instead of sod or earth. When such a fence is attempted in a level country, the wall must be very broad, not less than four or five feet, and the middle of it filled with earth; in short, the construction should be nearly the same as the Devonshire fence already described, only the facing on each side to consist of stones, in place of turf. The objections made to the Devonshire fence apply, with equal propriety, to this, being expensive in the erection, troublesome to keep in repair, and perishable in its nature.

There is however another kind of this fence, which in particular situations is extremely useful: that is, where the land has a considerable declivity, which terminates abruptly on the side of a highway, or an inclosure running along the side of high grounds, that lean very much to that side where the fence is intended to be made.

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This fence in the face of banks, represented Pl. VII. fig. 51. is commonly executed with a perpendicular front, and without any contrivance for carrying off the moisture; in consequence of which, after bad winters, or long continued rains, the earth swells, the wall bursts, and is thrown down: when the wall is of dry stone, there is little risk of this accident happening, as its open texture readily admits of the moisture passing through it; but when the wall consists of stone and lime, stone and clay, or any other that prevents the exit of the moisture, the earth, as already mentioned, swells, and the wall bursts, and is thereby destroyed.

To render a facing of this sort durable, it is requisite, if the wall is built with stone and lime, or a mixture of clay, turf, or any other materials, that resist the passage of water through them; instead of building it perpendicular, as is commonly done, to give it an inclination of some degrees backward, and to have openings at the bottom, at regular distances from each other, for discharging the moisture that may issue from the bank. In order to render these openings as completely useful as possible, it should have a space at the back of the wall, and immediately at the bottom, of about 12 inches broad, and the same depth, filled with small round stones; these, by serving as a kind of drain, will receive the moisture that soaks down, and afford it a ready exit by the openings we have described.

Hedge in the Middle, or in the Face of a Wall (Pl. VII. fig. 52.)—This fence, like the last described, can only be made in the face of a bank where the land rises immediately behind it: the practice is new, ingenious, and deserving of attention. It is executed in the following manner:—the face of the bank is first cut down with a spade, not quite perpendicular, but nearly so; a facing of stone is then begun at the bottom, and carried up regularly, in the manner that stone walls are generally built; when it is raised about 18 inches, or two feet high, according to circumstances, the space between the wall and the bank is filled up with good earth, well broke and mixed with lime or compost: the thorns are laid upon this earth in such a manner, as that at least four inches of the root and stem shall rest upon the earth, and the extremity of the top shall project beyond the wall. When the plants are thus regularly laid, the roots are covered with earth, and the building of the wall continued upwards, filling up the space between the wall and the bank gradually, as the wall advances upwards: when completed, the wall is finished with a coping of sod, or stone and lime. When the plants begin to vegetate, the young shoots appear in the face of the wall, rising in a perpendicular direction.

Sir James Hall, of Dunglass, has adopted this mode of inclosing pretty extensively upon

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his estates in East Lothian, and is the first who introduced that plan on the east coast from Gallom. The appearance is at once new and handsome; the whole seems to be in a very thriving condition, and in several parts the hedges have made great progress; most of them however being young, no decisive opinion can be formed as to the real advantages or defects, with which this mode of inclosing may be attended. Apparently, it is liable to several objections. In the first place, if from weakness, or other accidents, any of the plants should sicken or die, a circumstance by no means uncommon, even where every possible care has been taken, to select the stoutest and best; the defect thereby occasioned cannot be repaired without taking down the wall, at least as far as the place where the hedge was laid; this will be found highly expensive and inconvenient; the inconvenience would however be less sensibly felt, if the failure of the plants happened only in one part of the wall; but when, as will always be the case, the plants misgive in many different places, it will be found a very expensive and arduous business, to take down and rebuild the wall in every place where two, three, or more thorns have failed.

Were this labour and expence repaid by any extraordinary advantages, the practice might derive additional strength therefrom; that, however, is far from being the case; for though the plants in a hedge of this sort are, from the great quantity of earth laid upon their roots, less liable to injury from drought frost, &c.; they are at the same time farther removed from the genial influence of the sun and atmosphere.

There is one striking defect in the management of this fence, and we mention it with reluctance, as the proprietor is amongst the number of those who have paid great attention to the subject, and spared neither labour nor expence to set a good example. The defect we mean is in the dressing of the hedge, and proceeds upon mistaken principles: in place of allowing the plants to attain a certain size, say four or five feet, without cutting the tops, which when speaking of hedges in general, we have observed ought always to be the case, both the middle stems and lateral branches are regularly cut and switched once or twice a year; under this impression, that frequent cuttings, by making the shoots brush out at top, multiplies their numbers, and renders the hedge thicker and stronger. This idea is, in one respect, well founded; the numbers are no doubt increased by this mode of management, but their strength, taken individually, is thereby diminished; and in proportion to the length of time during which the practice is continued, the top shoots become gradually smaller and weaker; of course, the farther progress of the hedge upwards is prevented, and nothing can

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remedy the evil, but cutting down to the bottom, and allowing a sufficient number of vigorous shoots to come up. It is only, by allowing each plant to send up one or two stems to the height of five or six feet, that a strong durable fence can be formed; that point once gained, the whole of the after-management will consist in keeping it free from weeds below, pruning the side branches properly, and preventing its farther progress upwards.

In an experiment, the issue of which is still uncertain, it may appear rash to hazard a conclusion; but from every observation it would seem, that a hedge planted behind the top of the wall, like that last described, would sooner become a fence, would be less expensive, and liable to fewer inconveniences, than that, we are now speaking of. In the former, an easy opportunity is afforded of filling up the vacancies occasioned by the death of any of the plants, without the troublesome and expensive process of taking down, and rebuilding a part of the wall.

Hedge and Ditch, with Row of Trees (Pl. VII. fig. 53, and 54.)—The different kinds of hedge and ditch have been already described; the present differs from them only, in having a row of trees planted in the line of the fence along with the hedge.

The advocates for this practice say, that by planting hedge rows of trees in the direction of the fence, the country is at once sheltered, beautified, and improved; and that the interest of the proprietor is ultimately promoted by the increasing value of the timber raised in these hedge-rows. It is also said, that such trees produce more branches for stack-wood, knees for ship-builders, and bark for the tanners; and they sell at a higher price per load than trees grown in woods and groves. Besides, close-pruning hedge-row trees, to the height of twelve or fifteen feet, prevents their damaging the hedge; the shelter which they afford is favourable to the vegetation both of grass and corn; it also tends to produce an equable temperature in the climate, which is favourable both to the production of greater perfection and beauty in animals, and of longevity to man.

Though the practice of planting hedge rows of trees is very common (especially in England), though its advocates are numerous, and though these arguments are urged in its favour, yet objections are also entitled to very serious consideration.

When trees are planted in the line of a fence, if that fence is a hedge, the plants of which it consists, will not only be deprived of a great part of their nourishment by the trees, but will also be greatly injured by the shade they occasion, and the weight of the drop that falls from them during wet weather; upon this point little reasoning is

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necessary, for if we appeal to facts, we will find that no good hedge is to be met with, where there is a hedge-row of trees planted along with it.

The mischief is not however confined solely to hedges; the effects are equally bad, perhaps worse, where the fence is a stone wall; for though in this case the shade or drop of the trees, are hardly if at all felt, yet when they have attained a certain height, the working and straining of the roots during high winds is such, that the foundations of the wall are shaken and destroyed; accordingly, wherever large trees are found growing near stone walls, the fence is cracked and shaken by every gale of wind, is perpetually falling into large gaps, and costs ten times the expence to keep it in repair, that would otherwise be required if no trees were near it.

Admitting, however, that the trees in hedge-rows were no way prejudicial to the fence, which we have already shewn is by no means the case, another argument may be successfully used against the practice. It is seldom, indeed, that trees planted in hedge rows arrive at any great size; on the contrary, they are generally low and stunted, and while they occasion a visible loss by the mischief they do the fence, their utmost worth, when they come to be sold, will seldom be found adequate to the loss and inconvenience they have occasioned. This is very satisfactorily accounted for from the want of shelter; trees planted in hedge-rows being exposed to every inclement blast; by that means they are deprived of what is very essential to promote their growth, and which is in fact the cause, why trees in large plantations thrive better than when they are planted singly; namely, the mutual shelter which they afford to each other; it being observed that all trees on the skirts of plantations are much lower than those more removed from the extremity; this is owing to their bearing the first gust of the wind, which after being once broke, its violence is gradually abated, and in proportion as the trees recede from the verge of the plantations, they feel it less and rise higher.

Hedge-rows of trees are in a still more unprotected situation than those which form the skirts of a plantation, the latter being exposed to the violence of the wind only when it blows in one direction; this is what is generally termed the prevailing wind; when the gale is from any other quarter they can hardly be said to feel it; whereas, hedge-rows are exposed to the ravages of every blast, in whatever direction it may blow. There are, no doubt, some favoured spots where not only hedge rows, but even single trees may thrive, and attain a great size, without any protection whatever; the cases in which this happens, are however but few, and can in no sense be quoted in support of the general practice of planting trees in hedge-rows.

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It has often been hinted, and of late strongly insisted upon, though we think with infinitely more zeal than judgment, that the sides of all the highways throughout the kingdom should be planted with hedge-rows of oaks. Very elaborate and highly coloured statements have been given of the advantages that would result from the general introduction of this plan over the whole kingdom; but from much reflection, and a most attentive observation, we are enabled to state, that the supposed benefits held forth by the favourers of the system of planting the sides of the bighways, in lieu of serving the public, would produce quite a contrary effect. The mischief occasioned by hedge-rows of trees upon the fences by way sides, has already been mentioned, and those who have paid sufficient attention to the subject will bear testimony, that the roads are injured in a still greater degree. The circumstances necessary to form a proper road are, a good bottom, proper materials, and a sufficient declivity for carrying away the moisture, together with a complete exposure to the sun and air; where these are united, the road is good, and lasts for a considerable time; where any of them are wanting, the reverse is the case; for instance, though the bottom and materials are of the best kind, if the road is shaded with trees or tall hedges, and excluded from the benefit of the sun and wind, that road will always be a bad one, and scarce any exertion or expence will prevent it from being so; accordingly, throughout the whole kingdom, the worst roads are uniformly met with, in situations where belts of planting run parallel to them, or where very tall hedges grow on each side. The road contractors throughout the kingdom will, from dear-bought experience, corroborate this to their cost, as they uniformly find, that in every instance where the roads are bounded either by tall hedges, or belts of planting, the expence necessary to keep them in repair is more than doubled thereby, and the road, at the same time, worse than it is in situations where they are not shaded. This is remarkably the case, if the road runs in a direction from east to west: upon roads of that kind, if the south side is bounded either by a very tall hedge, or a hedge and row of trees, no pains or expence that can be bestowed, will be sufficient to keep it in good order. The great desideratum in road-making, as already noticed, being that of forming the road in such a manner as to raise it sufficiently in the middle, and give it a gradual slope to each side, to facilitate the descent of the moisture, and afterwards exposing it so completely to the action of the sun and air, as to dry it in the speediest manner after every shower.

It must be admitted, however, that in every situation, hedge-rows of trees, where they thrive, afford a degree of general shelter, and greatly improve the scenery; but these

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advantages are trivial when compared to their defects; and the injury done every year both to the fences and highways throughout the kingdom is too apparent, and too generally felt and complained of, both by farmers and road-contractors, to require any further comment.

Hedge and Ditch, or Hedge and Wall, with Belt of Planting (Pl. VII. fig. 55.) —In the introductory part of this Paper, notice is taken of the necessity of proprietors and occupiers of ground being at due pains to investigate accurately the peculiar circumstances connected with its natural situation, and to regulate their plans of inclosing accordingly, as without such previous knowledge and consideration, no undertaking of that kind can be ultimately successful.

This consideration is more necessary with the hedge and belt of planting, than perhaps any other fence; in exposed situations it is strikingly useful and ornamental, while, upon the low grounds it is not only unnecessary, but in some instances absolutely hurtful. For instance, in deep and broad valleys surrounded by hills, and sheltered from severe blasts, belts of planting are not only unnecessary, but even hurtful and ruinous by the ground they occupy, which could certainly be employed to greater advantage, and the original expence of inclosing and planting saved. There are many instances both in Scotland and England, of low, flat, rich lands, being inclosed, and completely protected from the inclemency of the weather, without any aid whatever from this fence. There are other situations, however, where, though the lands are very flat, and the soil good, yet, from the want of hills and high grounds in the neighbourhood, they are so much exposed to the sea blasts, and a current of air, passing over a great extent of country without any interruption, that the value of the soil is thereby very much diminished. The peninsula which forms the county of Caithness, is a striking proof of this: with a soil of a very good quality, and highly improveable, its value is greatly impaired by the circumstance of its being so much exposed to sea winds, which coming from a very inauspicious quarter, and blowing over a considerable extent of country without meeting with any obstacle to break the force, or change their direction, blow with uncommon severity and fierceness, and in that way are an effectual check to vegetation. There are very extensive tracts in England in nearly the same situation, the whole of which might at small expence be sheltered, and rendered completely productive, by intersecting the country in a judicious manner with plantations and hedges, either separately or conjoined, as in the hedge, and belt of planting.

Thus much, as to the situations in which this fence is proper and useful. In the

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formation of it considerable pains and attention will be found necessary. In every case where it is meant that the hedge and belt of planting shall constitute a durable and efficient fence, it must be made of a certain breadth; from forty to sixty feet is the very least breadth that should be allowed; and in cases where the situation is very elevated, and the intrinsic value of the soil small, the belts should be three times that breadth: such a space will allow abundant room for planting such a number of trees as will, by the mutual shelter which they afford to each other, promote their growth, and protect them against the blasts which are so severely felt in those elevated regions.

The more effectually to promote the desirable purpose of sheltering the young trees, they should be planted very thick; perhaps, four or five times the number that is meant to be allowed to grow to the full size, should be planted. The expence of the plants in the first instance will be very trifling, and much more than repaid, by the value of the weedings, after they have attained a certain age; with this additional benefit, that the whole plantation will grow faster, and in that way sooner answer the purpose of sheltering the lands. Planting an extra number of trees is also beneficial in another point of view, namely, that of affording a choice of the most healthy plants to be left when the plantation is thinned.

Where belts of planting are made it is common to have two sets of trees, one of firs, pines, or larches, and another of oak, ashes, and other hard woods; the first set is generally meant to shelter the second, and nurse them till they arrive at a certain age and size, when the first set are cut down. In some instances this mode answers extremely well, but in a multitude of cases it is otherwise; the firs, larches, and pines, grow so much faster than oaks, ashes, &c. as not only to deprive them of a very considerable proportion of that nourishment, which would otherwise have fallen to their share, but also, by shading and depriving them of the benefit of the light, they are drawn up in such a way as to bear more resemblance to hot-house plants, than trees that are meant to grow and encounter the blasts of a northern climate; accordingly it is too often seen, that when the firs and evergreens are removed, the tender branches of the oaks, &c. are instantly affected by the nipping blasts, in such a manner, as not only to check their growth for several years, but in many instances to kill them entirely.

To remedy this inconvenience, it is necessary that the belt should be made entirely either of firs and trees of that description, or of deciduous plants, such as oak, ash, &c.; in that way the whole plantation will enjoy an equal share of the light, heat, and air; and none of the trees will shade or prove detrimental to the others. It is known from

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experience, that plantations formed in this manner, if they are planted thick enough, grow equally fast, and form much stronger and healthier trees, that in cases where firs, and other trees of that description, are planted along with them.

Various modes are followed in the formation of belts of planting; sometimes they run in straight lines, sometimes serpentine, and at other times circular, or nearly so; all of which bave both use, and ornament to recommend them. Where it is meant to allow the fields to remain constantly in pasture, the serpentine and circular belts will not only look better, but will at the same time afford the most complete shelter: where the lands incline directly south, or nearly so, the belts should run from south to north, as the east and west are generally the prevailing winds in most parts of Britain: upon a north exposure, the belts should also run from south to north, but should be intersected with cross strips or belts at proper distances. By this management, the fields will be secured against every inclemeney of the weather; for while the belts, which run in a direction from south to north, screen the fields from the east and west winds, the cross belts effectually secure them against the inclemency of the north and north-west gales, which in many places, especially in North Britain, are severely felt.

The same precaution is necessary where the lands lean either to the east or west; in both of these cases cross helts will be found useful, as they effectually secure the fields against every wind that can blow. The reason for omitting the cross belts in southern exposures, is very obvious; the high grounds to the north secure them from north and north-west winds, the belts protect them against the gales, that come from the west and east; the only wind, therefore, to which they are exposed, is the south; and from the warmth and mildness of south winds, little danger is to be apprehended from their effects.

The manner of protecting these belts is different in different situations; where wood is plenty, a simple paling, or ditch and paling, forms the fence; where stones are plenty, a wall is frequently made use of; but in by far the greatest number of cases, the ditch and hedge already described (Pl. VI. fig. 42), or sunk fence described, Pl. I. fig. 4, with a hedge upon the top, are adopted; or any of these, when properly executed, will answer this purpose extremely well; but as there are some of them better and more durable than others, and as permanence ought never to be lost sight of, either in this, or any other mode of inclosing, it is of consequence to fix upon that, which unites immediate use with durability. The stone wall, sunk fence, and ditch and hedge, are certainly the most durable; the two first are, indeed, complete at once, and every

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benefit that can be derived from their use, is immediately obtained; the hedge and ditch, on the other hand, rises by very slow degrees, during which the belts are exposed both to the weather, and the injuries arising from sheep, and cattle breaking into, and trampling upon the young trees; after all, it is very seldom that a hedge which surrounds a belt of planting, forms a good or useful fence; in speaking of hedge and row of trees, the reason of this is explained at considerable length.

Where the mode of inclosing with belts of planting has been adopted, and judiciously carried into effect, the advantages have in many instances been very great, especially in high exposed situations. Upon the estate of Leston, in East Lothian, a striking instance of this is met with: a part of that estate is situated on the declivity of a range of hills, known by the name of Lammarmuir, leaning to the north. About twenty years ago, a part of the lands were inclosed with belts, consisting chiefly of firs, with a mixture of larches; the situation was then so bleak and exposed, and the soil seemingly so bad, that the neighbouring proprietors laughed at the attempt, predicted that it would be abortive, and considered the owner a fool, for laying out his money upon so unpromising a subject. A few years, however, gave them a better opinion, both of his intellects and his undertaking: the trees throve from the first, and in a short time, the benefit arising from their shelter was sensibly felt. The bleak uncomfortable appearance which the fields formerly exhibited, began to be changed, and a better and more valuable herbage sprung up. This alteration has been progressive, the pasture is now good, and the fields so completely inclosed, as to bid defiance to every wind that blows.

In consequence of this change, the soil, which in its original state produced nothing but heath, fern, and some of the very coarsest grasses, and was not worth a shilling an acre, is now rented at twenty, and not considered as a dear bargain; yields very good pasture; and notwithstanding its elevation above the level of the sea, and a north exposure, a part of it has lately been ploughed, and produced very good crops of grain. The sheep and young cattle that are reared and fed in these fields, owing to the complete shelter they enjoy, and being left undisturbed by herds, or dogs, thrive amazingly; and in winter, when the weather is inclement, the flocks from the neighbouring heights are drove into these inclosures during the night; and in that way are not only better sheltered, but the attendance of servants is rendered unnecessary.

To the above advantages we have to add, that the thinnings of these belts have much more than repaid the expence originally incurred in making them; by affording

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great quantities of wood for paling and for building, and keeping the houses and cottages upon the estate, and its immediate vicinity, in repair. After all, the number of trees still remaining, and which we hope the good sense of the present proprietor will allow to stand, would, if cut down and sold, be worth from £50. to £100. per acre.

Another very striking instance of the advantages arising from this kind of inclosure is met with, in the immediate neighbourhood of Haddington, in the same county, upon the property of the Rt. Hon. the Earl of Wemyss. A tract of land of about three hundred acres, on the side of a hill leaning to the south, was inclosed with belts, or as they are called strips, of planting; these strips run from north to south, in such a way as to divide the whole into fields, of from thirty to forty-five, and one of the fields contains seventy acres. Before they were inclosed, from the great elevation they were exposed to, they suffered severely from the east and west winds; the fields are nearly an English mile in length each, with a gradual ascent the whole way; and a part of the soil, especially that nearest the summit, rather thin, and of an inferior quality: the whole has been let for many years in pasture at a good rent, are now farmed upon a seven years lease for tillage, at five guineas per acre, while the lands on each side, which are not inclosed in that way, are scarcely worth twenty shillings. Pl. X. fig. 60. represents a part of these fields in perspective.

Many other instances could be adduced of the advantages, arising from this kind of inclosure in exposed situations; indeed, in such cases, it is the only one that should be had recourse to, as it unites every requisite of beauty, shelter, and inclosing. It has this farther advantage; that, whereas in other instances, the ground occupied by the fence, is either entirely, or in a great measure lost; in this case, it is annually improving in value by the growth of the trees, which at once afford wood for making fences, for building and labouring utensils, and, what in many districts is a very important acquisition, fewel for the poor: and in not a few instances, the branches or prunings have been in severe winters converted into food for sheep, and other animals, especially the prunings of firs, larches, &c.

In conclusion; we earnestly recommend this mode of inclosing, to the proprietors and occupiers of all high exposed grounds; as, from an attentive observation of its effects in such situations, the advantages arising therefrom, have been found to exceed even the most sanguine expectation.

Hedge and Ditch, or Wall, with the Corners planted. (Pl. VII. fig. 56, and Pl. VIII.

fig. 57.) It is common upon some estates, instead of the belt of planting, to plant only the corners of the fields, as in the figure. Upon an extensive property, and where the fields are not very large, this mode of inclosing has a good effect upon the scenery of the country, and answers the purpose of general shelter extremely well. It certainly has a more pleasing and natural appearance to the eye, than the stiff formal look of a number of straight belts running in parallel lines; it is, however, greatly inferior to the belt of planting, for the purpose of sheltering particular fields. But as in every field, there is a space in each angle that cannot be ploughed; by planting these spaces, which would otherwise be left waste, the country is thereby ornamented, and many valuable trees raised with little expence, and with scarce any waste of land. This plan is particularly recommended by Dr. Falconer, in the Staffordshire Report, in the following words. " In every act for an inclosure, let there be a clause obliging the proprietor " of the new inclosed land, to plant a certain number of oaks, in proportion to his " share of the inclosure, and directing the plantations to be made in the angles of the " fields; by adopting which plan, a less quantity of posts and rails would be required, " and the angles of each field would be converted to a profitable use, and corn would " grow close up to the rails; whereas no corn will now grow in such angles. This " is not the only advantage that would arise from this plan; the trees full grown, would " afford good shade for cattle, and an easy communication through these plantations, " would be from field to field. It would also be very ornamental to the country."*

Circular Belt of planting. (Pl. IX. fig. 58, and Pl. X. fig. 59.)— This mode of inclosing has hitherto been but little followed, though much benefit may certainly be derived from it; especially in the hills and uplands. The danger to which sheep are exposed in these situations during winter, is well known; numerous flocks being sometimes buried in the snow during the night, and not unfrequently the lives of the shepherds lost, in attempting to drive them to a place of greater safety. In the reprinted Survey of East Lothian, a Mr. Brodie, a very intelligent farmer in the uplands, proposes, that upon all store farms, there should be one or two circular inclosures, of at least six or eight acres in extent, planted thick with trees, and from an acre to an acre and a half, left unplanted in the middle, as in Pl. IX. fig. 58, with a serpentine road

* Others doubt the utility of this practice, as, in point of fact, the greater number of such corners are necessarily occupied by gateways that could not, without considerable inconvenience, and increasing the farmer's labour, be dispensed with.

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leading from the outside to the centre; and that during storms, or when there is any reason to apprehend a fall of snow, the sheep may be drove into them during the night, where they will be lodged in safety, and no herd required to attend them; and in bad years, such as the winter 1794-5, when the snow fell very deep, and continued for several months; during which, the farmers were under the necessity of feeding with hay, the sheep may be comfortably lodged, and fed in these inclosures; with this additional benefit, that if due pains are taken to litter the space in the middle with straw, heath, fern, or even peat earth, a very great quantity of valuable manure will in that way be obtained, which would otherwise have had no existence.

The reed fence has hitherto been but little used, except in gardens, for the protection of melon grounds, &c. and is constructed in the following manner. The space meant to be inclosed, is first surrounded with posts and rails, exactly resembling the fence known by the name of *post* and *rail;* when the wood work is finished, the reeds are applied perpendicularly in bundles, quite close to each other, and fastened to the post and rails, either with common *rope yarn*, the bark of trees, or ropes made of straw: when properly constructed, this fence lasts a considerable time, and affords the most complete shelter.

In some cases, the *reeds* or *thatch* (for this last article will answer the purpose equally well as reeds), are applied only on one side of the post and rails; in by far the greatest number of instances, however, they are applied on both sides; in that way the posts and rails are entirely concealed. This last is certainly the most complete method, and makes at once a more lasting fence, and one that is more agreeable to the eye. For temporary purposes in sheltering cattle, that are fed in open straw yards through the winter, and for protecting persons employed in hewing and preparing materials for buildings, the reed fence seems well adapted, and upon trial will be found to cost less money, and afford better shelter, than the wooden huts that are commonly erected for these purposes.

Gates.—Many different kinds of gates are used in different parts of the Island, but the principal are,

1st. The swing gate.
2d. The folding gate.
3d. The slip-bar gate.
4th. The wicket, or turn-about gate.

Pl. XII. fig. 67, 68, 69, represents the swing gates most commonly used. These,

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from the great length of the bars, and the weight upon the hinges, are found to be very expensive; for unless uncommon pains are taken to bind them very strongly together, the joints give way, and the gate falls to pieces; or the hinges being overstrained by the great length of the bars, are either drawn or broke; this is therefore to be considered as a bad and an expensive gate.

Pl. XII. fig. 70, and 71, represents the double or folding gate, which from experience, is found to be much more durable than that already described; the bars being only half the length, the joints of the gate are not liable to be broke, nor the hinges hurt by straining: and the difference in the original cost consists only in the price of any additional pair of hinges.

Pl. XII. fig. 72, represents the *slip-bar* gate. This is perhaps the most durable of any, especially where the gate-posts are of stone, with proper openings left for the reception of the bars. The only objection that can possibly be made to the slip-bar gate, is the trouble of opening and shutting; which, when servants, or others, passing through it, are in a hurry, occasions its being frequently left open. In other respects, it is preferable to every other description of gates, both in the original cost, and greater durability. It is to be noticed, however, that upon the verge of a farm or estate, especially where it is bounded by a high road; the slip-bar gate will not answer, as it does not admit of being locked, or secured in the same way as other gates; but in the interior of a farm or estate, it will be found the cheapest and most convenient.

Pl. XII. fig. 73, and 74, represents the turn-about, or wicket gates. These are used only in cases, where there is a necessity for leaving an entry for the people employed, to pass backwards and forwards. This purpose they answer very well, and at the same time keep the field completely inclosed, as they require no trouble to shut them.

Gate Posts.—These, where circumstances will admit of it, should always be of stone, and if possible, hewn stone; which, when properly constructed, lasts for ages. In many places, it is customary to plant trees for that purpose, and after they have attained a certain size and thickness, to cut them over about ten feet above the surface: where the trees thrive, they form the most durable of all gate-posts; in many instances, however, they misgive, and much trouble is necessary to repair the defect. Where the posts are made of dead timber, they should be strong, and the wood well prepared; that part which is let into the earth should be defended, by dipping it in coarse oil, or giving it a coat of Lord Dundonald's coal varnish, as formerly mentioned for the

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different kinds of paling; and all that is above ground exposed to the weather, should be well covered with one or two coats of oil paint; the expence of this preparation will be very small, and the benefit arising therefrom considerable.

There are also some stone stiles, very common in Derbyshire, and other parts of England, some sketches of which, transmitted by Mr. Brown of Lutton, are included in the annexed engravings; Pl. XII. fig. 75, is one of a very simple construction. At the bottom is a thin flat stone set edge ways, to prevent sheep getting out, and above, there is a cross stone or bar, to prevent horses and cattle jumping over. Pl. XII. fig. 76, and 77, require no particular description. Pl. XII. fig. 79, is called the *Cornwall* or *Cornish stile*. The foundation of this stile is a stone wall, in which a gap is left; and stones are laid across a ditch of some depth, made lengthways in the gap: the foot-passenger steps on the stones, but four-footed animals miss them, and fall into the ditch. Pl. XII. fig. 78, is the simplest and best construction, where the traffic is not great. In the construction of stiles, much must depend upon the nature, and shape of the materials; according to which, the nature of the fence, and the extent of traffic upon the road, the intelligent workman will execute the plan that is thought to be the most eligible.

CONCLUSION.

Having gone over with a degree of minuteness, which to many readers may convey an idea of trifling, the different kinds of inclosures, made observations upon the mode of executing each, and pointed out some of the principal benefits arising from the system of inclosing; we beg leave, in conclusion, to state its effects upon the population, manufactures, wealth, and public revenue of the kingdom. These are points of the highest importance, and entitled to the most serious, and attentive consideration.

It has been asserted by some able writers, especially the late celebrated Dr. Price, that the population of Great Britain has been materially diminished by inclosing the lands, thereby depriving a number of hands, formerly employed in the labours of the field, of employment: as the opinion of such a distinguished character, upon a subject of high national importance, cannot fail to have great influence upon many minds, it is entitled to a strict and unprejudiced examination. Before entering upon this, it is necessary to observe, that Dr. Price, however accurate his opinions, or calculations might be, when founded upon sufficient data, took certain things for granted, and founded upon them, which if he had been possessed of more experience or better

information, he would have disregarded. That this was the case in a remarkable degree, upon the present subject, is now so very notorious, that it may perhaps appear a waste of time, and an offence against the patience of the well informed reader, to repeat so palpable an error.

Were agriculture the only employment of the inhabitants of Great Britain, the produce of the soil their chief support, and the sole source from whence every thing connected with the necessity, comfort, and elegance of life was drawn; it would inevitably happen, that every contrivance, whether by inclosing the lands, or otherwise, that could in the smallest degree tend to diminish manual labour, would throw a number of persons out of employment, who would necessarily be obliged to seek a subsistence, by emigrating to other countries; in that way, the population of the kingdom would be *immediately* and *materially* affected. This conclusion must be very apparent to every person, who has considered the matter with due attention.

Let us however (which is really the fact), consider Great Britain, along with its agricultural products, as a warlike, a manufacturing, and a commercial nation; the picture is reversed, and the abridgment of labour, whether by inclosing, machinery, or other contrivances, will be found, in place of injuring, to favour population.

It cannot be disputed, that when a farm is well inclosed, and put under a proper rotation, with a certain proportion of it in grass, the stationary servants upon such farms, in most cases, will be reduced more than one third; and in a great many instances, fully one half: but though we admit this, we are at the same time satisfied, that the number of occasional labourers required for *ditching*, trimming, and cleaning hedges; and for hand-hoeing, hand-weeding, and other operations connected with an improved husbandry, will much more than compensate the diminished number of stationary servants: as every farmer will find employment for a great number of hands, for the labours already enumerated, and what is no small recommendation of this system of husbandry, a great part of the work admits of being done by old people, women and children.

Indeed, the slightest observation must impress every intelligent mind, that in proportion to the perfection in which any country is cultivated, its produce will be increased; of course, the greater the number of herds will it feed and employ. To what is the great produce and fertility of gardens owing, but to the superior care and attention bestowed upon their cultivation? We are still ignorant to what length the productive powers of the earth may be carried; they are certainly very great; and were every description of plants, but such as are necessary for the sustenance of man, and the

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other animals, extirpated, the produce of the soil would be increased, not in an arithmetical, but a geometrical proportion, to the quantum of labour bestowed upon it. Were the same pains taken, and the same number of hands employed in cultivating the fields, and in picking and destroying weeds, many extensive tracts might be rendered equally productive, as the best garden ground. It is obvious, however, that this system of husbandry admits of being practised with success, only upon inclosed fields; and that inclosing must, in all cases, be a previous step to its introduction.

This last argument is conclusive in favour of inclosures. It is admitted on all hands, that the system of husbandry, which a farmer is enabled to pursue upon inclosed property, has an immediate tendency to increase the produce of the soil, and afford employment for an additional number of people; while, at the same time, he has it in his power to diminish the working stock and stationary servants, nearly one half; the saving of corn, and other food required for the support of their horses, together with their original cost, the expence of stationary servants, harness, &c. &c. may be safely added to the account.

The question appears a proper and natural one, how is this extra produce to be employed? to which we answer, either immediately, in supporting an increased population, or remotely, in furnishing the country with an article of export, consisting either of the grain itself, or the products drawn from it, such as spirits, beer, porter, &c.; all of which are highly prized, and bear a great price in foreign countries. In a subsequent part of these observations, we shall have occasion to enter more at large into this part of the subject, as connected with the national wealth, and revenue; in this place it is only necessary to observe, that though by the assistance of inclosing, and an improved husbandry, the numbers of horses and stationary servants upon every farm are evidently diminished, yet the number of persons required for occasional labour, are as certainly increased; and in that way, the expensive (and in many instances unproductive) labour of a great number of horses, is exchanged for the valuable and productive labour of an additional number of human beings.

This is the immediate effect of inclosing, which, even in the outset is highly favourable to population; but if we carry our view forward to its remote benefits, they swell upon the sight, and assume an appearance of vast importance.

As far as population is concerned, in every instance where it is admitted, that either by inclosing, or any other contrivance, employment is provided for an additional number of hands, and a comfortable and certain subsistence is to be earned from such

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employment, the inducement to marriage, and the intercourse of the sexes, will be strong, and their effects certain; by that means a rising progeny will be produced, not merely adequate, but (as is always the case) more than sufficient for the labours of the district in which they are born, and a surplus will be spared for other employments. The petty mechanic, or labourer, who has been fixed to a certain spot, and has brought up his family by constant labour and self-denial, while he is from experience convinced of the certainty of a subsistence from such persevering industry, as long as his health enables him to prosecute his employment, will not, if he possesses common sense, be blind to the advantages to be met with in other walks of life.

Under such impressions, he will naturally educate his children for different professions, according to their inclination and his abilities. By that means, a certain proportion of the children, of those who cultivate the soil, will be qualified to fill other stations. The army, the navy, manufactures, the fisheries, and commercial pursuits, will of course present themselves, and be readily embraced.

The popular theme upon the subject of inclosing is well known; and many men, from whom more enlightened and extended ideas might have been expected, have added their voice to the general and unfounded clamour. It is certainly not unworthy of notice, that the same objections have been made, and the same reasons urged, against the introduction of machinery in various branches of manufactures; yet it is notorious, that in every instance, where machinery has been applied for the purpose of lessening manual labour, the manufacture has extended itself, and been the means of increasing both the wealth and population of the kingdom.

The outcry that was made against spinning and stocking machines, is still recent in the remembrance of many; the reasons assigned were, that the women would be deprived of employment, in the principal line in which their industry would be exerted (spinning); and that by the introduction of stocking frames, many who had formerly lived by knitting stockings by the hand, would be thereby rendered destitute.

The same resistance has been made to the different improvements in agriculture:— thrashing machines were reprobated, as they would deprive that description of men of a subsistence, who formerly lived by thrashing grain by the hand. Two-horse ploughs, one of the most valuable of modern improvements, were exclaimed against, for the same reason; and though the number of horses, and stationary servants, were by that means alone reduced one half, it was gravely urged, that it would not only deprive

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many persons of employment, but in the end induce a scarcity of servants; as when there were no plough drivers to learn the management of a plough, while they were young, there would be none to replace the old ones when they were wore out. It is the same with regard to inclosing, which has been represented as so very unfavourable to population, by depriving a great number of persons of employment.

Experience, and facts which cannot possibly be denied, prove that the fears entertained upon these subjects were groundless; and a conviction of the utility of machinery, and other contrivances for shortening manual labour, both in agriculture and manufactures, has now made converts of their warmest opponents; but it required nothing short of the experience we have had of these advantages, to subdue obstinacy or enlighten ignorance.

Amongst the lower ranks of society, whose minds are uninformed, the aversion to any improvement that has a tendency to shorten labour, even in the slighest degree, is exceedingly natural; unacquainted with the immediate benefits, and incable of carrying their views forward to the remote advantages, that may result from such inventions, they foresee, in their adoption, only a diminution of their own importance; and by observing that fewer labourers are required for certain purposes, they are haunted with the apprehension of being deprived of employment, and their families reduced to want; in that way, feeling, not reason, decides their opinion; whereas, where they to look round them, they would observe that new inventions and discoveries, whether in manufactures or rural economy, always bring in their train of additional employment for many hands, and an increase of comfort and profit to all concerned. Let the situation of the farmers and their servants throughout Britain, fifty years ago, be contrasted with their present ameliorated condition,—the picture will no doubt appear striking.

A very natural inquiry arises from this comparison; to what is this great difference in the condition of these people, owing? unquestionably to an improved system of husbandry, the increased demand for labourers of every description, the advanced price of labour, and the ready sale and high price of the products of the earth.

Upon certain subjects, facts are so strong as to preclude the necessity of reasoning; the present is of that description; in every point of view, inclosing is highly advantageous; the produce of the fields is thereby increased, food is provided for an additional population, labour is diminished, by which means the greatest possible produce is raised at the least expence; and by rendering the necessaries of life plentiful and

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cheap, our manufacturers are enabled to conduct their operations at less expence, and by that means undersell other nations where living is dearer, even in their own markets. This last is a matter of great importance; as a preference thereby arises to our manufactures, and a preponderance is given to the scale, that settles the balance of trade in our favour.

Hitherto we have considered the increased produce, as applicable chiefly to the support of an additional population; we will now carry our views somewhat farther, and consider grain, or the products drawn from it, as a bulky and valuable export. Perhaps the policy of government will take care to prevent much of the grain from being exported, in an unmanufactured state; but the same wisdom which dictates the propriety of preventing the exportation of grain, will point out the utility of encouraging the exportation of the products drawn from it; such as spirits, starch, &c. &c.; these products, when exported, not only bring into the country much more money than the grain itself would have done, but afford employment for many people, and are productive of great advantages to the agricultural interests of the nation, by the quantity of manure that is produced, and the number of hogs and cattle that are fed by the distillers, brewers, and starch makers.

The experience of ages convince us that, even in the best years, the produce of the kingdom seldom greatly exceeds the consumption; and that, taking one year with another, it is barely adequate to it: this leaves little surplus for any misfortune arising from bad seasons; the calamitous year 1782, and the scarcity and enormous price of grain in the years 1795 and 1796, are proofs of the truth of this: during these two last years, the money paid for grain imported was nearly three millions sterling; the bounties paid by government amounted to £573,418. 4*s*. 9*d*. making together almost four millions; if to this, we add the loss sustained by the revenue from the stoppage of the distilleries and starch works, and the money sent out of the country for the purchase of foreign spirits, starch, &c. the whole together will amount to an immense sum in the present state of the country, and sufficient to arouse the attention of the legislature to prevent a similar misfortune. This, it is admitted by intelligent men, can only be done by a strict attention to the improvement of our agriculture, and giving due encouragement to every thing that can tend to perfect so valuable an art. Next to tillage, and the use of manures, inclosing bids fairest to accomplish this desirable purpose; even upon the present arable fields, which from their remaining open are in a defective state of cultivation, its advantages are very great; but upon lands that are

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entirely waste, they are still more considerable; the value of the former is, in many instances, more than doubled: upon the latter, a quantity of provisions equal to all they produce, whether in corn or cattle (and which would otherwise have had no existence), is added to the common stock. In this last case, the question of population is in no respect doubtful; if a tract formerly barren, is inclosed, and either converted into pasture, or brought under the plough; employment is thereby found for a number of people: and a spot which, while in a waste state was useless to the community, becomes valuable in a double point of view, by adding to the stock of provisions, and affording employment for an additional number of hands.

A nation is accounted rich, in proportion to its resources, and strong, in proportion to its population, and means of defence. Inclosing has evidently tended to increase both the resources, and population of Britain. If this is admitted, the increase of the public revenue follows as a matter of course; for the greater number of inhabitants that live in any country where taxes are paid (and in the present state of society they are unavoidable), the greater quantity of taxable commodities will be consumed; consequently, the national revenue will be increased in the same proportion.

Before we take leave of this subject, we judge it necessary to observe, that when the strength and riches of a nation are spoken of, they are very seldom estimated by their true standard; national strength in all cases implying the number of inhabitants, and national wealth, the produce of their joint labours, whether arising from agricultural manufactures, or commerce. In the first estimate, it is often forgot, that when the gross population of a country is taken, the number of persons who are capable of active exertion, and whose labours add something to the common stock, bears but a small proportion to the total amount; and when the gross produce is mentioned, the number of hands required to raise it, is as frequently left out of the amount.

National strength, undoubtedly depends in a great measure upon the number of inhabitants, but it is only upon the numbers who are capable of active exertion, in one way or other: and though national wealth, and public revenue, consist in the annual income, arising from the joint labours of the community; yet it is perfectly certain, that the true criterion of the wealth and independence of any people, is to be met with, in a comparison between the numbers, and the produce. In other words, the nation that is able to realize the greatest annual produce with the fewest hands, and at the least possible expence, is the richest and most independent. In this respect Britain stands unrivalled; many of the noblest inventions, of which the human mind is

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capable, have lately been introduced, and applied to the useful purposes of life. In consequence of which, manual labour has been so much abridged, as to enable the mechanic and manufacturer, to bring to market articles of superior quality, at less than a third of the price which they would have cost twenty years ago; owing to that cause, our exports have increased in a very uncommon degree, and we are now enabled to supply other nations with many articles of luxury, and even of necessity, which we formerly imported from them.

The dress and appearance of all classes of society, is another proof of this remark; the extension of every manufacture, where machinery has been introduced, the increased demand for workmen, and the high wages given, are conclusive proofs, that the application of machinery to manufactures, is highly favourable to population. It is the same with regard to agriculture; for though by inclosing, the introduction of two-horse ploughs, and thrashing machines, fewer persons may be wanted for certain purposes; yet a number, far exceeding the persons formerly employed in these branches, will be required for other labours. Let it also be remembered, that even in the Highlands, and grazing districts, where inclosing tends without all question to diminish population; yet the progressive improvement of other districts, by opening new sources of wealth and comfort, finds ample employment for all the hands that are rendered unnecessary in the grazing countries, in new and hitherto unknown branches of industry, which not only admit of the labours of the young and vigorous, but afford a profitable employment for children, who are unfit for other labours, and even for decrepitude and old age.

Let us for an instant suppose this country in such a situation, that the number of inhabitants was barely adequate to the present labours in agriculture, and manufactures; under such circumstances, no attempt even to extend the present, or introduce new arts or manufactures, could be successful for want of hands. For though by high wages, people might be tempted to forsake their former avocations, and embrace this new employment; it is evident, that these hands must be drawn either from the plough, or some manufacture formerly established. In such case, the new art or manufacture could only be established at the expence of the agriculture, or former manufactures of the country; in that way, the nation would be in no respect benefited; as whatever was gained by the new art, would be more than counterbalanced by the check and discouragement given to the old.

But if in a country so circumstanced, where the population is barely adequate to

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the labour required for agriculture, and the other established branches of industry, machinery, or other contrivances can be introduced, that have a tendency to diminish manual labour in the whole, or any one of these branches, it is evident, that a number of hands will by that means be spared for any new undertaking; and in that way, the country would reap every advantage that could possibly arise from this new art, without the smallest detriment to the old. For, as has been already hinted, it ought never to be forgot, that though some idea of the industry of a nation may be formed by knowing the number of hands actually employed in the useful arts, the perfection of these arts depends upon that nation being able to bring to market the greatest quantity of produce, with the fewest hands, and at the least possible expence; for numbers without industry, constitute a wasteful and consumptive population, which, instead of serving any valuable purpose, has a tendency to diminish the national wealth, and destroy its resources.

EXPLANATION OF THE PLATES.

PLATE I. *fig.* 1. An open ditch, with the earth taken out of it collected into heaps, and burning for manure; a practice in some of the English counties.

——— *fig.* 2. A double ditch, with the earth taken out of both ditches, formed into a bank, and laid up between them.

——— *fig.* 3. Section of a road or highway, bounded on each side with a bank, having a perpendicular facing of sod on the side next the road, and sloping gradually towards the fields; on the other, with a hedge planted at the bottom of the slope.

——— *fig.* 4. A sunk fence faced with stone.

——— *fig.* 5. Horizontal nailed coarse rails, made of common sawn wood, without any other dressing.

——— *fig.* 6. Jointed horizontal rails, made with dressed wood, and jointed instead of being nailed.

——— *fig.* 7. Upright lath paling, made with light sawn laths, and supported with rests at proper distances.

PLATE I. *fig.* 8.	Horizontal fir paling, made with weedings of young firs, with the lateral branches trimmed off, about two inches from the stems.
PLATE II. *fig.* 9.	Upright paling of young firs, with the branches left in the same situation.
——— *fig.* 10.	Chain fence, made with upright posts drove into the earth, and chains stretched between them.
——— *fig.* 11.	Chain fence, with trees instead of dead posts, and the chains fastened to hooks or staples, drove into the trees.
——— *fig.* 12.	Net fence, made by driving massy upright posts into the earth, and stretching nets between them.
——— *fig.* 13.	Rope fence, made by driving upright posts into the earth, and stretching ropes between them.
——— *fig.* 14.	Moveable paling, flake, or hurdle fence.
——— *fig.* 15.	Osier or willow fence.
——— *fig.* 16.	Paling of growing trees.
PLATE III. *fig.* 17.	Upright lath paling, or park palings.
——— *fig.* 18.	Horizontal lath paling.
——— *fig.* 19.	Warped paling.
——— *fig.* 20.	Open nailed paling, warped with thorns.
——— *fig.* 21.	Common dead hedge.
——— *fig.* 22.	Dead hedge bound together at top; used in many parts of England.
——— *fig.* 23.	Dead hedge with upright posts drove into the earth, and warped with thorns, or *stack* and *rice*; or, as it is termed in Scotland, *stake* and *rice*.
——— *fig.* 24.	An old hedge cut down, and a gap in the middle of it, mended by bending down one of the old plants into the opening, fastening it down with wooden hooks or pins, and covering it with earth; when this is properly done, it sends up a number of strong young shoots, which completely fill up the opening.
PLATE IV. *fig.* 25.	A hedge mended in the above manner, and the opening protected by a coarse paling.

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PLATE IV. *fig.* 26. An old thorn hedge cut down, and an opening filled up with young beeches, protected by a paling.

——— *fig.* 27. A hedge mended with dry stones; a very bad practice.

——— *fig.* 28. The common quick hedge, to be seen in many parts both of England and Scotland, with the stems of the plants cut about half through, then bent down a little, and bound together at top with willows or hazels.

——— *fig.* 29. A quick or white-thorn hedge with the foliage upon it, trained in such a manner as to leave it broad at bottom, and tapering gradually towards the top.

——— *fig.* 30. An old hedge cut down, with the first year's growth of young shoots upon it, after cutting.

——— *fig.* 31. Another old hedge cut down, with a part of the old stems left uncut and warped with it, to fill up the gaps.

——— *fig.* 32. A whin hedge on the top of a bank faced with stone.

PLATE V. *fig.* 33. A whin hedge on the top of a bank.

——— *fig.* 34. A stone wall coped with brick.

——— *fig.* 35. A stone wall coped with sod.

——— *fig.* 36. A galloway dike or wall.

——— *fig.* 37. The front of a brick wall.

——— *fig.* 38. A turf wall.

——— *fig.* 39. Turf and stone wall.

——— *fig.* 40. A mud wall, with a mixture of straw.

PLATE VI. *fig.* 41. Frame of a mud wall.

——— *fig.* 42. Hedge and ditch.

——— *fig.* 43. Hedge and ditch, with a coarse open wall upon the top of the bank, to protect the young thorns.

——— *fig.* 44. Hedge in the face of a bank.

——— *fig.* 45. Hedge at the bottom of a bank.

——— *fig.* 46. Hedge on the top of a bank.

——— *fig.* 47. Devonshire fence.

——— *fig.* 48. Hedge and paling.

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PLATE VII. *fig.* 49.	Hedge, with a dead hedge on the top of the bank, to protect the young plants.
——— *fig.* 50.	Hedge and wall.
——— *fig.* 51.	Hedge on the top of a wall.
——— *fig.* 52.	Hedge in the middle of a wall.
——— *fig.* 53.	Section of hedge and ditch, with row of trees.
——— *fig.* 54.	Front view of hedge and ditch, with row of trees.
——— *fig.* 55.	Hedge and wall with belt of planting.
——— *fig.* 56.	Perspective view of an inclosed field, with the corners planted.
PLATE VIII. *fig.* 57.	Plan of four fields, with the corners of each planted.
PLATE IX. *fig.* 58.	Circular inclosure consisting of several acres, with a large area left in the middle, for sheltering sheep in hilly countries during snow.
PLATE X. *fig.* 59.	Another circular inclosure for the same purpose.
——— *fig.* 60.	Belts of planting.
PLATE XI. *fig.* 61.	A back view of a brick wall, supported by pillars to strengthen it.
——— *fig.* 62.	A back view of a stone wall heightened with brick, with pillars to strengthen it.
——— *fig.* 63.	A stone wall with a light paling on the top.
——— *fig.* 64.	Section of a double ditch and hedge, with a row of trees on the top of the bank between them.
——— *fig.* 65.	A frame and plummet used by masons in the building of dry stone walls.
——— *fig.* 66.	Section of a dry stone wall.
PLATE XII.	Gates and stiles.

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Plate I.

Fig. 1.

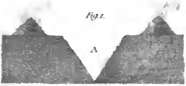


Fig. 2.

Fig. 3.

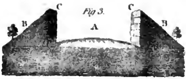


Fig. 4.

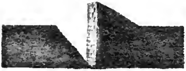
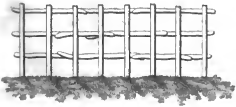


Fig. 5.



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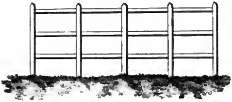
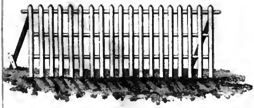


Fig. 7.



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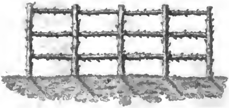

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Plate II.

Fig. 9.

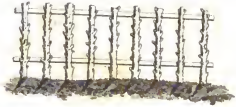
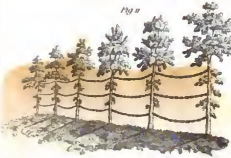


Fig. 10.

Fig. 11.



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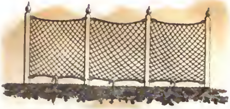

Fig. 13.

Fig. 14.

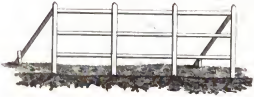

Fig. 15.

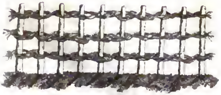

Fig. 16.

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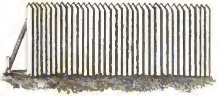
Plate III.

Fig. 17.



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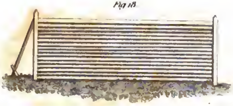

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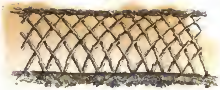

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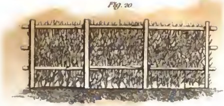

Fig. 21.

Fig. 22.

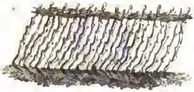

Fig. 23.

Fig. 24.

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Plate IV

Fig. 25

Fig. 26

Fig. 27

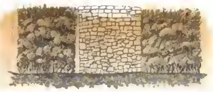

Fig. 28

Fig. 29

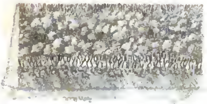

Fig. 30

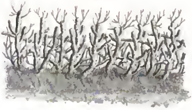

Fig. 31

Fig. 32

Neele sculp^t 352 Strand.

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Plate V.

Fig. 33

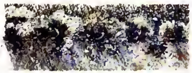


Fig. 34

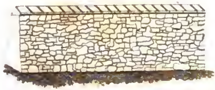


Fig. 35

Fig. 36

Fig. 37

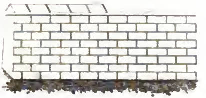


Fig. 38

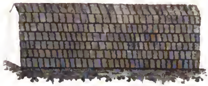
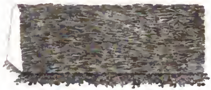


Fig. 39

Fig. 40



Neele sculp 352 Strand

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Plate VI

Fig. 41

Fig. 42

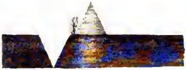

Fig. 43

Fig. 44

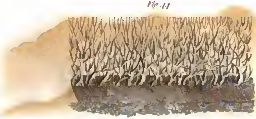

Fig. 45

Fig. 46

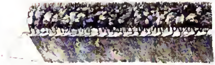

Fig. 47

Fig. 48

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Fig. 49

Fig. 50

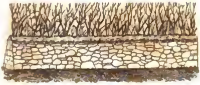

Fig. 51

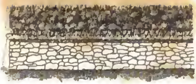

Fig. 52

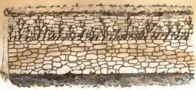

Fig. 53

Fig. 54

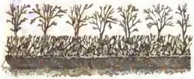

Fig. 55

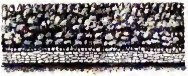

Fig. 56

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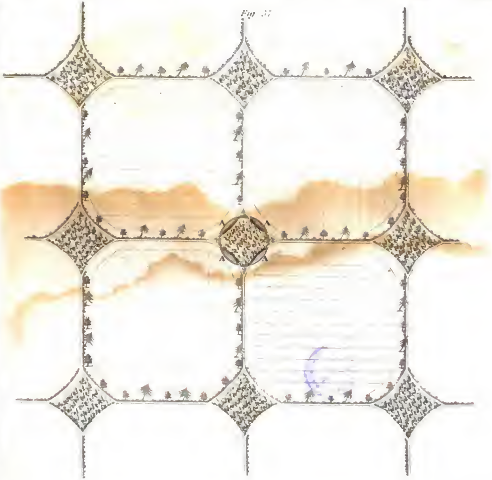
Plate VIII.

Fig. 37



A.A.A.A. Represent the Watering Places for the Contiguous Fields supplied from the Ditches.

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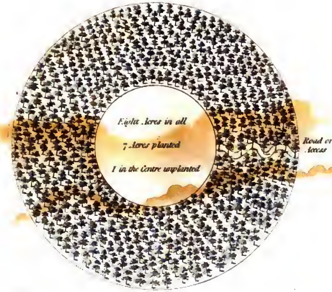
Plate IX.

Fig 38



To guard against such dreadful calamities (the loss of whole Flocks of Sheep in mountainous Countries during the winter season) We propose as a remedy that a round Beech *plantation containing about eight Acres of ground should be raised in a convenient situation upon every store Farm, and that one Acre should be left unplanted in the middle which would afford excellent shelter. The walk into it might be serpentine, so that, if the Trees were close and thriving no winds could penetrate into the fold that would be hurtful to the Flock. The leaves of the Beech remaining on during the winter renders that tree peculiarly well calculated for that purpose.*

NB: *The Inner Circle should be covered with Straw, Rushes, Peat Earth &c. for the purpose of making Manure*

Fig 59

Fig 60

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Plate X

Fig 61

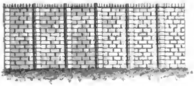

Fig 62

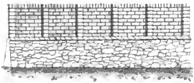

Fig 63

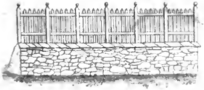

Fig 64

Fig 65

Fig 66

Neele sculpt 352 Strand

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Fig. 67.

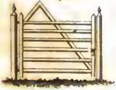


Fig. 68.

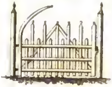


Fig. 69.

Fig. 70

Fig. 74.

Fig. 73

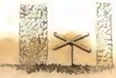


Fig. 72

Fig. 71

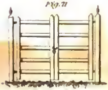


Fig. 75.

Fig. 76.

Fig. 77

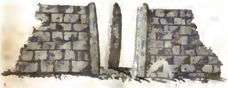
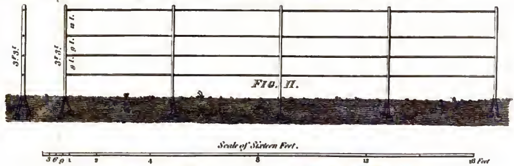


Fig. 78.

Fig. 79

Plans of Horizontal & Perpendicular Wire Fences presented to the Board of Agriculture by John Grant Esqr of Waltham Place, Berks.

FIG. I.



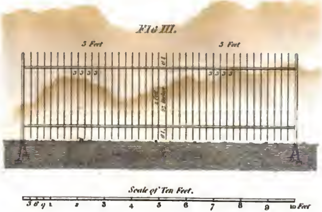


FIG II. or Horizontal Wire-Fence, was applied about 16 Years ago by Mr Grant at Waltham Place, Berks, to keep off Cattle, Sheep &c from the Lawn;
The expence was for the Iron 6d p. running foot; & of Lead, Stone & Workmanship, 6d more; or in all 16s 6d p. Perch: It is strong and durable, requiring only a little Green Paint:

But he prefers FIG III. or perpendicular Wire-fence, which has been erected at Sir John Call's at Whiteford-House, near Callington, Cornwall, about 20 Years; it is he thinks a stronger Fence & better calculated to keep off Cattle or Sheep from Pleasure-Grounds by means of the pointed Wire, than the horizontal fence; but he believes the expence will be double that of the Horizontal fence.

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II.

A short Sketch of the Drainage and Improvement of a Marsh, near Marazion, in Cornwall; describing a peculiar Mode of taking off the Water, and securing the Land from the Overflowing of the Sea. By RICHARD MOYLE, *of Marazion.*

A PIECE of land called the marsh, or bog, near Marazion, in Cornwall, containing thirty-six statute acres, has, from time immemorial, been covered with two or three feet of water, and which at spring tides was overflowed with the sea, by means of a river which passed through the land. This ground looks towards the south, and is separated from the sea by a long skirting of sand of about seventeen acres, over which the turnpike road passes towards Penzance, on its most elevated part; on the north of the marsh lies some croft ground,* which gradually rises as it retires from the bog, so that the marsh is surrounded on the north and south by elevated spots; and the water on its surface usually crept away to the sea by means of a river, through which the water at high spring tides always had access. From the depressed situation of this marsh, it was impossible to take off all the surface water through the river, and recourse was had, for this purpose, to a square wooden pipe of nine inches diameter, which was introduced at that part of the shore called half ebb, and which was eight feet lower than the surface of the marsh. This pipe was introduced through the sandy soil, in some places twenty-four feet deep, till it arrived to the south part of the bog, where it was found to be six feet under the surface. At this place a reservoir of eighteen feet square, and eight feet deep, was immediately cut out; and the water draining from the marsh, during the time the tide was in, was received in the reservoir, and discharged when the tide was out, through the pipe with great velocity. The sea, at high water covers this pipe with nine or ten feet of water: a long trench of three feet deep and five wide, was extended from this place, east and west, on the south side of the bog, for its whole length, bordering on the sandy soil; and at the distance of every sixty yards, a similar trench was cut up directly north towards the croft, which divided the whole marsh into oblong square fields. By the means of these trenches, or open drains, the whole surface water was conveyed directly to the reservoir, and thence

* Croft ground, is higher spots not subject to inundations.

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to the sea. The pipe at both its extremities was guarded with valves, which shut at the approach of the tide; and during its flowing, the water accumulated about two, or two and a half feet high in the reservoir; and as the sea retires, the collected water runs off without any interruption, till the next return of the tide: the pipe is covered with the sea six hours in every twelve. This singular mode of drainage answers uncommonly well, and has never once failed in five years: the extremities of the pipe have also iron bars placed before them, to prevent the intrusion of extraneous bodies. As soon as the surface water was removed, a strong embankment of turf was made on the south and east sides, to prevent the overflowing of the tides; and the water, which formerly diffused itself over the whole of this ground, was collected into a river, and carried to the sea on the outside of this embankment. In cutting the open drains, a pot of copper coins, containing about a thousand, was discovered three feet under the surface, and which appeared to belong to the Emperor Victorinus, who reigned in the third century. These coins were much injured by the corrosion of the salt water; but several were still perfect enough to trace the outlines of the Emperor. As soon as the evaporation had assisted the consolidation of the surface, the air, within a mile of the marsh, became so strongly impregnated with a sulphureous smell, as to render the place quite obnoxious to passengers.

On examining the different strata, we found that two feet and a half of the surface consisted of mud and a peaty substance, most strongly interwoven with the roots of gos *(arundo phragmites)* and common rushes, which were the only substances that grew spontaneously on its surface; below this, was a stratum of three feet and a half of pure peat, of a very inflammable nature, and which seems to have extended over twenty acres of the marsh; under the peat lay a bed of sand, from four to six feet deep; from which we may conjecture that the whole was formerly an arm of the sea, and that the dropping of vegetables, and deposition of mud (which possibly formed the peat), had gradually expelled the sea; except at spring tides. This stratum of sand does not appear to be the original bed of the sea; for on streaming for tin, another floor from six to ten feet deeper was discovered, consisting of round smooth pebbles, and gravelly substances, containing tin; among which were willow trees and hazel nuts, in the most perfect state.

Mode of Improvement.

The surface was pared and burned, and after repeated ploughings, &c. for two years, large bodies of clay, with manure, were then carried on its surface, and a slight

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crop of white oats with ever-grass (ray), common and Dutch clover, sown in the spring. The saltness of this ground was so very powerful for the first three years, as to destroy every crop; on the fourth, the land began to vegetate partially; but on the fifth, or present year, 1798, every part seems to be quite alive; so that every kind of vegetable now flourishes with great luxuriancy. It has afforded this summer very good crops of hay, and an abundant and rich pasture, with a prospect of improvement the next season. The expences of draining this ground, with trenching, paring, ploughing, burning and manuring it, with the failure of three years' crops, amount to a very considerable sum; and this distressing circumstance is increased, on its being only a leasehold for three lives.

The sandy land has been partly inclosed, and covered with large bodies of clay and manure; it has afforded remarkably fine crops of turnips, and the grass of this season has been very luxuriant. The crofty land on the north (twenty-two acres) has been all cultivated, first with potatoes, and afterwards sown with wheat, barley, oats, and turnips, and produced very good crops.

The whole of this improved ground has been productive of considerable advantages to the public, particularly to the poor. Four hundred persons yearly receive turf from it: two hundred and fifty are fed most plentifully with potatoes, which are planted here by very poor people, who are, in consequence of having land given them, become uncommonly industrious; and the whole neighbourhood, by its drainage, have got rid of low nervous fevers and agues, with which it was continually pestered.

The whole ground under improvement, consists of seventy-five acres, of which thirty-six are marsh, twenty-two croft, and seventeen of sand. In 1798, forty acres were under different crops; *viz.* wheat two acres and a half, barley nine, oats eight, turnips two, potatoes five, bay and pasture thirteen and a half.

On the sides of every open trench is planted a row of quicksets, interspersed with a few planes and pineasters. These are defended from the cattle and blights, by means of a temporary turf hedge, and promise to afford a pleasing division of the land in a few years. To every inclosure of the marsh, a part of the rising ground of the croft is annexed, to accommodate cattle in wet seasons.

RICHARD MOYLE.

Dated Marazion, 24th October, 1798; when this land was visited and examined on the spot as to the facts, by Sir John Call, and the above particulars given him by the proprietor.

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III.

An Embankment against the Sea.

SIR, *Penhurst near Battle, 31st January, 1797.*

THE embankment against the sea, that I mentioned when last at the Museum, is upon the estate of the Earl of Ashburnham, at Pembrey, in the county of Carmarthen, whither his lordship sent me upon his coal and other business, and with directions to see if I could devise any method of preventing the sea from making further incroachment upon his property, which it had been doing for many years; and particularly in October 1795, had broke in and covered many hundred acres, damaged the houses, buildings, stack-yards, and gardens; and it was the general opinion, that a regular embankment must be formed, which would cost some thousand pounds, he having several miles of coast. The view that I first took was upon a very windy day, and the shore an entire sand, which extended at low water many miles. In riding along, I perceived that any piece of wood, or accidental impediment to the course of the sand, raised a hill: it immediately occured to me, that by making a hedge at the weak and low places, with wings to catch the sand as the wind blew it in different directions, I should obtain the desired effect. I therefore directed stakes nine feet long to be cut, and drove one foot and half into the sand, at two feet and half distance from each other; betwixt which I had furze interwove so, as to form a regular furze hedge seven feet and a half high. Of this since last June, I have done eleven hundred and thirty seven yards; and in October last when I was there, a great deal of the hedge was covered, and since that time I am informed by letter, that a great deal more of it is so; and that the neighbouring inhabitants draw great comfort to themselves, from the security my furze embankment gives them, as its present appearance plainly evinces that at a trifling expence, I can secure Lord Ashburnham's estate from being inundated; for whenever the first hedge is not high enough to prevent the sea overflowing, another may be built upon the the sand formed by that hedge, and so on in succession, till it is perfecly safe.*

I am, &c.

ANTHONY TATLOW.

* Sir Thomas Hyde Page, had long ago executed similar embankments.

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Communications to the Bd. of Agriculture Vol. II

Plate XIV

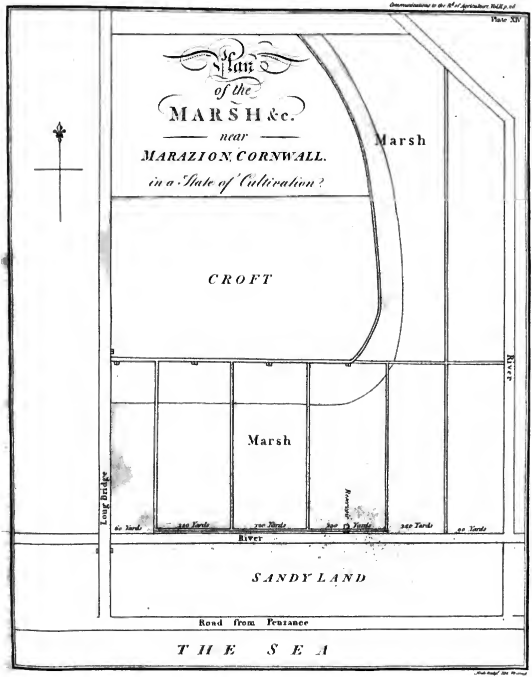

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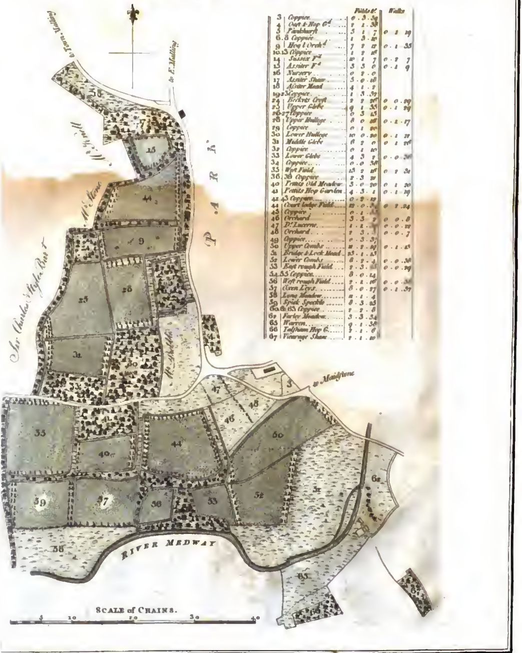
Plate XV.

FARM at TESTON in KENT.



		Fields &c.	Walks
3	Coppice	0 . 3 . 39	
4	Oast & Hop Gd.	2 . 1 . 38	
5	Pinkhurst	5 1 7	0 1 19
6. 8	Coppice	1 3 . 10	
9	Hog l Orchd.	7 2 12	0 . 1 35
10.13	Coppice	1 2 16	
14	Sussex Fd.	10 1 7	0 . 2 7
15	Assiter Fd.	3 3 0	0 . 1 9
16	Nursery	0 2 . 0	
17	Assiter Shaw	3 . 0 . 18	
18	Assiter Mead	4 1 . 2	
19.23	Coppice	1 . 3 . 39	
24	Becketts Croft	2 2 26	0 0 . 29
25	Upper Glebe	9 1 35	0 . 1 29
26.27	Coppice	0 3 15	
28	Upper Hullage	8 0 26	0 . 2 . 17
29	Coppice	0 1 20	
30	Lower Hullage	10 0 . 20	0 . 1 21
31	Middle Glebe	6 2 0	0 1 26
32	Coppice	0 1 10	
33	Lower Glebe	4 3 2	0 . 0 . 30
34	Coppice	0 . 0 38	
35	West Field	13 2 26	0 2 31
36. 39	Coppice	2 . 3 20	
40	Pettits Old Meadow	3 . 0 20	0 1 20
41	Pettits Hop Garden	4 . 3 . 1	0 . 1 . 19
42.43	Coppice	0 . 2 . 12	
44	Court lodge Field	12 . 0 . [illegible]	0 2 . 24
45	Coppice	0 . 1 . [illegible]	
46	Orchard	3 . 3 . 2	0 0 . 8
47	Dr. Lucerne	1 . 2 . [illegible]	0 . 0 . 22
48	Orchard	2 3 . [illegible]	0 . 0 . 7
49	Coppice	0 . 3 . 3[illegible]	
50	Upper Combs	12 . 2 . 19	0 . 1 . 13
51	Bridge & Lock Mead	23 . 1 . 13	
52	Lower Combs	6 . 2 . 4	0 . 0 . 30
53	East rough Field	2 . 3 . [illegible]	0 . 0 . 29
54.55	Coppice	8 . 0 . 14	
56	West rough Field	2 . 2 . 16	0 . 0 . 3[illegible]
57	Oxen Leys	8 . 0 . 27	0 . 1 . 37
58	Long Meadow	12 . 1 . 4	
59	Spick Speckle	8 . 3 . 25	
60.61.65	Coppice	2 2 . 8	
62	Farley Meadow	3 . 3 . 34	
63	Warren	9 . 1 . 38	
66	Tolfham Hop G.	3 . 1 . 6	
67	Vicarage Shaw	2 . 1 . 20	

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IV.

Queries relative to the Farm at Teston in Kent, answered by Sir CHARLES MIDDLETON, *Bart.*

Query 1. *What number of acres does Teston estate contain?*

Answer. The farm in hand at Teston, called the house farm, contains two hundred and fifty acres.

Q. 2. *What is the general nature of the soil?*

A. The upper part of the farm is a hazel mold upon a lime-stone: the middle part, towards the river Medway, consists of a rich clay, mixed with sand called *comb*: the part adjoining the river is of the same nature, but having a greater proportion of the sand.

Q. 3. *What the estates were let for, or reputed to be worth, when Sir Charles Middleton began his improvements?*

A. This farm was let at about fourteen shillings per acre, when I began to improve it: it was the full value of it at that time; but it would now let for thirty shillings per acre, and upwards.

Q. 4. *What was his progressive system?*

A. The farm of which you desire an account, fell under my management in the year 1770. It consisted at that time of about two hundred and twenty acres; it had been ill managed, and was in general out of heart, and overrun with weeds. The lower grounds were much subject to land springs, and for want of draining afforded little or no produce. In the first year, the whole amount of the product was only two loads of hops from six acres, forty-one quarters of wheat, twenty-seven of barley, twelve of peas, and thirty loads of hay and clover; value in all, six hundred and ninety-four pounds; whereas I have had on the same farm, in its improved state, nineteen loads of hops, one hundred and thirty quarters of wheat, thirty-seven of barley, one hundred and thirty-seven of beans, five thousand two hundred and forty bushels of potatoes, and eighty three loads of hay; value in all, four thousand two hundred and twenty-seven pounds: our hops selling as high as nine pound per cwt. at both periods.

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When I first undertook the management of this farm, I determined to spare no expence in improving it. It is situated towards the south, on a slope, and the Medway is its boundary in that direction.

I considered six acres of hops, as much too small a quantity in proportion to the size of the farm, under proper management; though probably sufficient, in the circumstances in which it then was. And as I could not expect to be reimbursed any great expence, from so small a quantity of land as the farm consisted of, without extending the cultivation of hops; I determined, as soon as the quantity of manure would permit, to increase the hop grounds gradually to thirty-two acres.

The farm, however, being in a foul and unproductive state, I resolved to fallow the whole of it by degrees, and in the meant time to sow every field that afforded any prospect of a crop, in order to procure straw for manure.

In the second year, my crops varied very little from the former; but I had the satisfaction to find them gradually increase, as the improvement advanced, and continue so to do, till it was completed.

The first step towards improvement was to employ a drainer, which cost upwards of two hundred pounds, before he had finished. My next object was to procure, by winter stalling of oxen and hogs, as much manure as the quantity of straw on the farm would produce; and to improve the meadows and arable, by fattening sheep on them, with turnips and oil cake. The oxen were kept on potatoes, carrots, and cabbages, with a mixture of hay and oil cake; sometimes on flax-seed ground with barley, and at other times on linseed oil, mixed with cut hay.*

These trials have been all registered; but it would take up too much of my time to extract them. The journals, however, are set apart, and shall be in due time at the service of the Board.

As increasing the hop-ground could not be accomplished without procuring large quantities of manure, and as it was necessary to be as sparing as possible in applying it to the arable ground, I was very soon obliged to give up the cabbage and carrôt culture, and to confine myself to such green crops as could be fed on the ground: otherwise I must have fallen into the too common error of sacrificing the arable to the hop-ground.

As soon as the farm was got into tolerable order, as to cleanness and draining, I brought it under the following course of crops, *viz.* 1. turnips fed with sheep

* The oil cake, however, excels all other food for winter fattening.

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on oil cake and hay; 2. barley; 3. clover; 4. wheat; 5. beans or peas mended; 6. wheat; 7. oats. The crops seldom fall short of seven quarters of barley (often eight) per acre; the clover from two to three tons in both cuttings; the wheat from four to five, and even six quarters; the beans from seven to ten; and the oats from eight to ten. These crops were equally great in 1795, a year of scarcity, as in any other year; which I impute to the heart in which the ground has been kept, and the nature of the culture.

Having advanced in a great degree towards the improvement of the fields, I considered a Kentish farm as defective, if it could not furnish itself with such a number of hop-poles, as would serve a due proportion of hop-ground; and which, on this farm, may be reckoned at twenty or twenty-five acres. This, at the rate of four hundred annually to an acre, is from eight to ten thousand poles. I therefore began plantations of ash, chesnut, and willow, as fringes round all the arable fields, and in the spare corners; and made them of greater or less breadth, as suited best for squaring the fields. I considered that, in this way, a smaller quantity of ground would be sufficient for the purpose, than in common woods; for, as the narrowness of the plantations admitted the sun and air to reach every plant, the wood grew equally in its size, and produced a very considerable number of poles, more than could have been produced from an equal space of ground in a wood. This part of my design has been accomplished, and I have already cut some thousands of poles from these plantations. Besides the very great advantage of having poles on the spot, and an improvement of at least four pounds per acre annual rent on the ground, it gives a pleasant appearance to the farm, and adds considerably to the warmth and preservation of the crops. These plantations were all cultivated to the most advantage: the old hedge rows were grubbed up, new quickset hedges planted, the plants set out from four and a half to five feet distant, potatoes raised in the intervals for three or four years, the plantations regularly dug in spring and autumn, and the digging continued as long as the roots of the plants would admit of it. The progress, in consequence of this cultivation, has been very rapid, and few plants lost; in the front of these plantations I have made walks of ten or twelve feet wide, and which produce from four to five tons of good hay annually, and add to the pleasure of the farm.

As long as the culture of these plantations was continued, I kept a large quantity of hogs, and folded from seventy to a hundred on the clover leys, and fed them in the fold with the potatoes which were dug up in their neighbourhood. I found this

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practice succeed so well, that I generally afterwards planted an acre or more in the middle of each clover field, and fed them on the ground. The produce in general was given to store hogs and fatting beasts.

The meadows were so very indifferent when I came to the farm, and so overrun with ant-hills, and rushes, that I ploughed the worst of them up in succession, and planted them with potatoes the first year, and with turnips, fed with sheep and oil cake, for two years afterwards; and then laid them down again with grass seeds. But as no management will procure a sufficient quantity of manure, to mend meadows in a country where hops are the chief produce, I always save the after-grass for fatting sheep, which are fed on oil cake in the same manner, as when on turnips. They are put on in October, and continued till the meadows are finished; they are then put on turnips. By this method, the meadows are kept in tolerable heart, and produce from one, to one and a half load of hay per acre: the sheep are fed in the same manner on the clover leys before wheat sowing, and it answers as well as with the hogs.

The number of our oxen fatted annually is about twenty-six, of hogs twenty-five to thirty; there are also three cows, and seven horses. The quantity of manure made annually by these means, *including what the horses make on lucerne in the yard in summer*, is from eight hundred to a thousand cart loads, of twenty-two bushels each. With this quantity of dung, and about eighty pounds worth of rags, the cleaning of ponds, and the scraping of roads, the farm is kept in very rich order: the number of sheep fatted, *communibus annis*, is about three hundred; all the straw is made into manure, and none consumed in any other way: the quantity produced from the farm, including cut stubble, is about one hundred and thirty loads a year. The expence of the farm, one year with another, is about two thousand pounds; and the profit arising from it since 1770, after the payment of all expences, has been nearly twelve thousand pounds; to which may be added in improvement three thousand pounds more; making together fifteen thousand.

I have lost very considerable sums by fatting beasts and sheep, without having saved myself in any one instance, that I can remember. Our annual consumption of oil cake on this farm is about forty thousand: this year, I take it for granted, I shall be out of pocket by fatting stock more than two hundred pounds, reckoning hay at the market price. In this conjecture I do not speak at random; because every kind of expence has been registered, from the first of my commencing farmer; yet, with all

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these losses attending feeding in this way, I find it answer on the whole; and without such expences I could not possibly keep up the quantity of hop-ground, in the state in which it now is. We look, in general, to hops for profit; and most farmers in this neighbourhood think themselves well off, if they do not lose by their arable; owing, in my opinion, to the error which I have stated above.

My statement at Michaelmas 1796, after all expences of improvement had been reimbursed, was as follows:

	£.		£.
Hops cropped - - -	7736	Crop on farm, deducting rent and expences	1000
Arable ditto - - -	2240		
	——	Stock - - -	1200
	9976		——
Improvement of land - -	3000		2200
	——		12976
	12976		——
			15179

This, Sir, is a general outline of the manner in which I have proceeded on this farm: the particulars are contained in many books and journals, which one day or other shall be at your service; but the labour of abstracting them is too much for me at present.

A journal is always carrying on: the farm is managed by books of general instructions in my absence, and by occasional memorandums when I am present. In this way, I never found any difficulty in carrying it on, either while I was at sea, or in office.

The plan which I send, may not exactly agree in point of extent with the number of acres which I have given, owing to some additional pieces having been laid to the farm; but on the whole you will find it tolerably correct. I wish I could make it convenient to give you more particulars; but my time and health will not admit of it.

Q. 5. *What was the excess of his expenditure beyond the produce each year, comprehending the original annual rent?*

A. The expenditure and receipt from the year 1772, when I first began farming, have been as follows; and if the supposed improvement, and the value of the stock in hand, and of the present crop, be added, it will give nearly the profit arising from these improvements; the interest of the money employed at five per cent. being regularly added.

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It ought to be observed that the farm, from my first management of it, continued to produce crops in proportion to its improvements; which crops being deducted from the original sum employed, account for the fluctuation of expences: but till the year 1783 it could not be said to be in such a state of improvement as to be able to produce great crops. From that time it has generally paid a good balance, and in favourable hop years a very great one.

Years.	General balance against the farm.	Balance in favour of the farm each year.
1771	£.943	
1772	2036	
1773	1604	
1774	2026	
1775	3516	
1776	3464	
1777	3565	
1778	3279	
1779	3434	
1780	3502	
1781	3309	
1782	3550	
1783	2972	
1784	2471	
1785	771	
1786	368	
1787		£.3198
1788		1630
1789		231
1790		933
1791		641
1792		393
1793		1005
1794	697 loss	
1795		152
		8183
		687
		7496

	Value of stock, crops unsold, and crop on the ground, deducting expences.	
Stock in hand	£.1600	
Crops	2000	
Improvement at least	3000	6600
		£.14096

Q. 6. *How many years was it, till the produce had reimbursed the expenditure, and the farm began to afford an improved income?*

A. Fifteen years, *viz.* from 1771 to 1786. It must, however, be observed that, during that time, no expence was spared to get the farm into such a state as to produce a great return, whenever favourable years of hops should happen.

Q. 7. *What are the principal crops produced on the farm, and what is their rotation?*

A. The farm consists of

	Acres.
Hops	32
Meadow and pasture	55
Arable	119
Coppice and plantations	31
Orchards	8
Grass walks round the fields	8
	253

The common rotation of crops from the arable part is,

1. Turnips,—2. Barley or oats,—3. Clover,—4. Wheat,—5. Beans or peas,—6. Wheat,—7. Oats.

Q. 8. *How is the farm manured, and by what means is such manure procured?*

A. The farm is manured with dung made from seven horses, four cows, twenty-six stalled oxen, and about forty hogs. The whole of the straw and stubble, amounting to about one hundred and thirty loads, is used in litter. The dung produced in this way will amount, *communibus annis*, to about seven hundred and fifty or eight hundred cart loads of rough dung; each cart containing twenty-two bushels of half-rotted dung.

To this add about £80. value in woollen rags: lime occasionally, though but seldom: and the scrapings of roads, and mud from ponds, both together amounting to about one hundred loads annually.

No manure is to be purchased in this country.

Q. 9. *What has been the annual expence of the farm for these last ten years, and what has been the annual produce, so as to form a medium of both?*

A. The annual expence of the farm for these last ten years, has been £1965.: and the produce sold has been £2400. The stock, however, in hand, which is very considerable, as well as a share of the improvement, amounting to at least £3000. is included in the expence.

Q. 10. *In what manner are hop-poles raised, and great quantities of potatoes produced?*

A. Hop-poles are raised either in natural woods, or in copses or plantations made for that purpose. The first are generally of oak, intermixed with beech and birch: and are cut from twelve to eighteen years growth, according to the nature of the soil. They begin cutting in the autumn, and reserve the first and second poles till the spring, for the advantage of the bark. The copses are small slips of wood round the fields of the farms, consisting of alder, willow, and ash, and are commonly cut at nine or ten years growth. The plantations being either of ash, willow, or chesnut, are on good ground, fit for poles at the same age.

Potatoes have been raised on the young plantations, on meadows broken up for improvement, and in the arable fields.

Q. 11. *What is the profit or loss of fattening beasts or sheep upon oil cake; and at how much a ton is manure thus acquired; and how many tons are laid per acre, and for what crops?*

A. From the experience which I have had of fattening beasts and sheep for the London market, I cannot, on an average of twenty years, estimate the loss on beasts at less than fifty shillings per head; and on sheep fatted on turnips, with clover, hay, and oil cake, at two shillings and sevenpence each. In this account nothing is charged for attendance; which on beasts may be ten shillings per head, and on sheep one shilling.

Manure acquired in this way, without charging the straw, costs three shillings and sixpence per cart load, of twenty-two bushels, as carried out of the yards.

Beasts, from one to two hundred stone of eight pound to the stone, when bought in half fat, will eat fifty-eight trusses of hay of fifty-six pounds each, and five hundred oil cakes. And sheep, weighing from twelve to fourteen stone when fat, two trusses of clover, and fifty-two oil cakes, besides turnips, to complete them.

Twenty-five loads of dung, as carried out from the yard to the mixen' in the field, is used per acre for turnips; twenty for peas or beans; and twenty-five for hop grounds.

I have lost this year by fattening oxen £6. per head, owing to the high price at which they were bought in; and their backwardness in flesh when bought. As this account differs so widely from the sanguine representations of most of the writers on agriculture which I have read, it must surprise the Board; but the facts are as I have stated them. Nothwithstanding the expensive rate, at which I am obliged to procure

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dung in this way, I find it answer on the whole; and the farm, from the high state of cultivation in which it is hereby kept, very seldom suffers from blight, and as seldom varies in the quantity of its corn produce.

Q. 12. *What are the expences and products of an acre of hops, on an average of the last seven years?*

A. Expence £32. 10*s.* per acre.

Products £39. 18*s.*

I must, however, observe, that of the last seven years, two have been very bad, two only very good, and three very indifferent.

But from my experience as a hop planter, I think the expence of a well cultivated acre of hop ground, mended annually and substantially polled, may be reckoned in a period of twenty years to cost from £33. to £35. per annum, and to produce £46. thus yielding a profit of £·2. per acre one year with another.

Q. 13. *Does Sir Charles prepare his cattle for fattening by previous bleeding, or physic; and if so, what are the effect of such preparation?*

A. The cattle have been invariably purchased at fairs, or from breeding farmers. They have been received from grass, and have never undergone any preparation for fattening; but I have little doubt of the practice being a good one.

For other particulars see answer to Art. 4.

CHARLES MIDDLETON.

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No. V.

Observations on the State of America. By William Strickland, *Esq. of Yorkshire. Received 8th March, 1796.*

[Mr. Strickland, having been favoured with some queries from the Board of Agriculture, before his late visit to the United States of America, in which were pointed out objects of inquiry, connected with the institution of the Board, and particularly deserving his attention, takes the liberty of returning the following answers to them. He is satisfied that they are by no means complete, nor as worthy of the inspection of the Board as he could have wished them to have been; he hopes, however, that the imperfections will prove to arise rather from having omitted much, than from having stated that which is inaccurate; and that it will be considered, that his residence in that country was short, the country very extensive, and that other objects demanding his chief attention, might be very numerous.]

York, Fb. 27th, 1796.

"*What is the price of Land?*"

In taking an agricultural survey of the United States of America, our inquiries are rendered more easy in one instance, than they would be, in that of any other country, from the circumstance of one superficial measure only, being there made use of, the statute acre of England. As far as I could find, no other measure is known or referred to; but in other instances, the result will prove very different; in Europe, and in England particularly, mere locality occasionally excepted, the quality of the soil has the chief influence on the price, and will in every country effect it, in proportion as agriculture is well understood. In Europe, the produce of the land is the object of the purchaser, or the rent, which to the owner, is the same thing; in America, quality of soil has little influence on the price; for there, agricultural knowledge in general is at the lowest ebb; for unless the land be actually incapable of producing any thing from being mountain or swamp, the quality of it is little considered in the purchase. This circumstance I should have been apt to have attributed to the great variety of produce

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cultivated in the country, in consequence of which every variety of land would be applicable to some of them, had I not observed the same uniformy of price, where the kind of articles cultivated was much more limited. In America, the price of the land is chiefly affected by the vicinity of easy conveyance of the produce, or of the great towns on the Atlantic, the chief seats of consumption and export; but the situation of it on navigable waters has always a greater tendency to increase the price, than distance from the coast has to depress it.

One other very essential difference is also to be pointed out; in Europe, rent must ever be connected with price, and that is influenced by the quality of soil; in America, rent is never thought of, for land is very rarely let; what instances of it have occurred, and what information I could procure respecting it, I shall hereafter state; but first, I shall proceed to the price; and with that view commence with Massachusets, Rhode Island, and Connecticut. These states, being in so many instances circumstanced alike, having no *back-lands*, as called, that is, lands lately taken up or settled; being all situated on the sea; all of the same early foundation; covered with an uniform and abundant population; inhabited by the same unmixed race; governed by the same laws, principles, and customs; actuated by the same spirit of order, industry, economy, and enterprize, may properly be taken together, under the general name of

NEW ENGLAND.

This is universally an hilly country, of irregular surface, very rocky, in most parts great masses of stone lying on the surface, or starting abruptly from it, but no where what may be termed mountainous; the green-woods, as they are called, running along the western extremity of it, and which are part of that chain of mountains which traverse the continent of North America, in the north-east and south west directions, are here of no very great height, and would, I believe, admit of cultivation in almost every part of them; certainly where I crossed them in the north-west part of Massachusets, where they by no means come under the description of mountains. The soil of New England has in general a tendency to clay, variously mixed with sand and loam, but nothing of a calcareous quality is known in any part of it.

The country is chiefly applied to the breeding and grazing of cattle and sheep; for which, from the verdure, and great inclination to produce herbage, it appears to be particularly calculated. No great quantity of grain is grown; I believe not sufficient

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for the maintenance of the people; so that in general the consumption demands import, certainly never admits of export.

All along the coast of New England, as far north as Boston, land sells on an average by the farm at from £3.* to £3. 15*s.* per acre, and is eagerly sought after at that price; much of this land is not of a good quality, and all of it greatly exposed to the influence of the sea. About Boston the price is considerably higher, particularly if near the town; a gentleman residing there, has an estate within three miles, consisting of three hundred and eighty acres, divided into two farms, which he has great difficulty in letting, and then only for £52. 10*s.* per ann. of which he does not receive more than £30. the rest being laid out in improvements and cultivation; besides which, he partly stocks the farms, having twenty cows upon them, his property. Supposing the land to be worth £3. 15*s.* per acre, this estate, cows included, does not net more than two per cent.

No person here will rent land.

About Dudley land sells at £6. per acre, and upwards.

About Hartford, it will not produce more than three and a half per cent. and it is difficult to let it at that rate. A gentleman there, eight years since, gave £4. 10*s.* per acre for some wood land, and has since been offered £9. per acre for the wood only; timber and wood having doubled in price, in every part of New England, within ten years.

Very good land about the town Springfield, will let so as to produce five per cent. About Northampton, land, on the banks of the Connecticut, of most excellent quality, fit for every purpose of pasturage or cultivation, would sell for £5. 5*s.* or £6. per acre; in favourable years this land would produce as high as twenty bushels of wheat, per acre, but more commonly produces fifteen or sixteen. About Chesterfield, land will sell according to situation, from £2. 5*s.* to £4. 10*s.* per acre. Here I saw a farm of one hundred and eighty acres, which three years since cost £135. in a very rocky, steep, and wet situation, but very abundant in grass.

Here, therefore, the average price is £4. per acre, and pretty uniformly declines as it is situated more inland, except in the instance of the range along the coast, the

* I have throughout reduced the various denominations of money met with in the United States, and the various currencies of the different States, to sterling; in larger sums, omitting minute fractions, but inserting them where their relative proportion to the sum could be of any material value.

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price of which may probably be lessened by its exposure to the sea; and the land appears to pay about three and a half per cent. interest.

NEW YORK.

This being the state in which the greatest land speculations take place, and to which the emigrants from Europe, who have any property, chiefly turn their attention, which from climate, the cheapness and plenty of land, the convenience of transport, the nature of the government, and laws and manners of the people, seems to hold out the most favourable circumstances for settlement, it will require to be particularly examined. In the immense range of country in the west part of this state, land may be got on very low terms; much of it is yet barely known, and much of it is either yet *unlocated*, or if *located*, only by those land jobbers who have purchased from the government of the state, vast tracts at very low prices, with a view to sell them again as soon as population should approach their districts.

The lower part of this state much resembles the country last described, being rocky and uneven, but in most places admitting of cultivation. About fifty miles from the coast, the country is traversed by the before-mentioned range of hills, called, properly enough, the Highlands of New York; they are of considerable but unascertained height, probably about one thousand, or one thousand two hundred feet, and in many parts are entirely covered with woods, and apparently never will admit of cultivation, and may extend in breadth about fifty miles; beyond them is a fertile, beautiful, irregular country, extending to Albany, and thence back many miles to the country now only beginning to be settled. The soil much resembles that of New England, and has nothing of a calcareous quality known in it. This is the granary of North America; and a great quantity of wheat is now brought to Albany, from at least an hundred miles beyond it, grown on the banks and branches of the river Mohawk.

From the state of New York, many parts of the continent are supplied with grain; and from the city of New York, and the ports on the river Hudson, more grain and flour are exported, than from any other port in the union, except perhaps Philadelphia. Here also grain is cheaper on an average than elsewhere, according to the present price, by at least sixpence per bushel.

Fields within two miles of New York will let for from £2. 14*s.* to £3. 7*s.* 6*d.* per acre, to gardeners, &c.; in some instances I am told at still higher prices. An estate within and joining to New York, bought five years since for £1575. was sold in the

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summer of 1794 for £7312. 10*s.* and was (in September, 1794) again selling in lots for building upon, and the purchaser expected to clear a very large sum. Another estate near New York, confiscated during the war, was purchased about seventy years since for £956. and sold lately for £112,500.

Phillips's Manor, which was likewise confiscated, was sold by the state for various prices, from 11*s.* 3*d.* to £5. 12*s.* 6*d.* per acre; no average for the whole can be drawn, some of it being incapable of cultivation. Near Mount Pleasant, £393. 15*s.* was asked for ninety-six acres, of which thirty were wood, with a good new house upon it worth £56. 5*s.* or per acre £3. 10*s.* Near Peckskill, a farm of four hundred and forty acres, one hundred of which were cleared land on a stream in a valley, the rest wood on mountains, not much of which was capable of cultivation, but in the woods sixty head of cattle might be maintained, would let for £14. per annum, and the price asked for it was £393. 15*s.* or per acre 17*s.* 10*d.*

A farm near King's Ferry, of two hundred and forty acres highly cultivated, well planted with fruit trees, in their prime, a good house upon it, with every thing in good condition, lately sold for £3375. or per acre £14. 2*s.*; but then a convenient situation for trade added greatly to the price.

At Fishkill, a farm of one hundred and forty acres cost £223. 15*s.* or per acre £2. 6*s.* 3*d.* Close to the town of Poughkepsie, land sold at £28. 2*s.* 6*d.* per acre, in small quanties.

Near Clermont, an English gentleman purchased five hundred acres for £2812. with a good house upon it, which was reckoned in the purchase at £562. 10*s.* every thing in excellent condition, one hundred and fifty acres of it containing very fine timber, and the whole lying on the Hudson, or per acre £4. 14*s.* This was reckoned a good purchase.

At Stephen-town, about twenty miles from Albany, and as many from water carriage, land sells at from £2. 5*s.* to £2. 16*s.* per acre. A gentleman in Albany bought a farm near that place, in 1789, for £22. 10*s.* which he has since sold for £393. 15*s.* and supposes it now worth double that sum.

Many tracts in all this country to the westward, bought within these few years, have since been sold for tenfold profit; and in small tracts for much more.

An estate of one thousand acres, two hundred and fifty of which are best *river side* land, the rest pine land, but level and capable of cultivation, and some already cultivated on the Mohawk, opposite Schenectady, beautifully situated, with an house upon

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it, estimated in the purchase at £562. 10*s.* is to be sold for £5625.; or per acre about £5.

An extensive patent of excellent land, on the Mohawk, belonging to an English nobleman, was lately sold for less than 4*s.* 6*d.* per acre; while ten thousand acres very near it, through which the river ran, and which was sold four years since for 7*s.* 10½*d.* per acre, was at the same time again upon sale, and the price asked for it £1. 2*s.* 6*d.* Many men of family and fortune in England possess large tracts in this state, and the land speculators of the country are particularly eager of dealing with them.

A gentleman gave, in 1791, £22. 10*s.* for six hundred acres of soldiers' grants, and sold them, in 1794, for £331. 10*s.* or 11*s.* per acre. A few years after the peace, he gave £16. 17*s.* 6*d.* for one thousand acres in Jellisfonda, which he sold in November, 1794, for £393. 15*s.* or per acre 7*s.* 10*d.*

Land at Konondaigua, on Seneka lake, which in 1789 would scarcely sell for 5*d.* per acre, two years afterwards sold for 2*s.* 9*d.*; four years after for 6*s.* 2*d.*; and I saw some of it sold in 1794, by public auction, in tracts of three hundred acres and upwards, for 8*s.*

A gentleman bought a tract of land in 1792, at Konondaigua for 2*s.* 3*d.* per acre, which in November, 1794, he sold for 9*s.* to one who purchased it to sell again.

A gentleman of rank in England, about the year 1790, purchased one million of acres on Lake Ontario, in what is called the Chenesse country, for about 1*s.* 10*d.* per acre, which would in November, 1794, fetch from 4*s.* 6*d.* to 5*s.* 6*d.* when sold in large tracts of one thousand acres or upwards, and about 13*s.* 6*d.* when sold to settlers in smaller parcels, who have ten years credit; paying interest at the rate of seven per cent. during part of the time, or who purchase on some such terms, according to agreement.

A person of Hudson, had a large tract on the west of Lake Seneka, which he bought of the state in 1787, at 7½*d.* per acre, and which, December, 1794, sold for 6*s.* 9*d.* to a speculator to sell again. This land lies the farthest west of any I have yet heard of, being sold in this state; beyond it, the country is scarce known.

A person residing in Upper Canada, has a *township* of land consisting of one hundred and thirty thousand acres, at the junction of the Oswegatchi and the St. Lawrence, for which he was offered in January, 1794, 7½*d.* per acre, having put it up to sale at New York, to see whether it was at that time of any value; but many people

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having removed into that country, in the course of the summer, he was offered in December, 1794, 4*s.* 6*d.* per acre for it.

Hence the average price of land, in the old settled country below Schenectady, (rejecting such as being mountainous is little capable of cultivation, and such as for mercantile purposes, or from being in the vicinity of large towns, is of increased value) appears to be £3. 7*s.* 10*d.* per acre, and of the new settled country to the west of it, 9*s.* 3¾*d.*

So little land is rented in this state, except in the vicinity of towns, that there are no grounds on which to state the interest paid by purchases; I suspect, however, that it no where exceeds three and a half per cent.; but considerable tracts of land in the old Dutch patents, are what is here called, but improperly, rented; being granted out on leases for three lives, renewable on certain immutable terms, or on very long leases, or leases for ever, with a certain reserved rent usually in wheat, as from fifteen to twenty bushels per hundred acres, with various feudal services and payments annexed, of varying and uncertain value; but these do not afford sufficient data, on which to calculate the rent or interest. Proprietors of lands in this state are still in the habits of granting them out on similar terms.

NEW JERSEY AND PENNSYLVANIA

May very properly be taken together, the former appearing, as it were, part of the latter, extending eastward towards the sea; great part of it is a low, flat, sandy, wet, unhealthy country, little frequented, and less cultivated. Inland of this tract in Jersey and Pennsylvania, is a dry, rising, irregular country, consisting chiefly of what is here called isinglass land, a sandy soil full of micaceous particles, glimmer, and talc; from which the surface of the country, while the sun is shining, acquires a singular appearance; most of the remainder is a deep red loam approaching to clay, and which probably would have most of the properties of it, in a climate where there was more wet and less sun, is of great fertility, and capable, by proper cultivation, of producing every thing of which the climate will admit.

This country continues, with considerable variations in parts, to the chain of mountains which traverse the two states. These mountains are chiefly composed of micaceous granite, in some places on a limestone, or marble base; they run in parallel ribs of great height,* and are in general very barren, and covered in many parts with

* The highest ridge of these mountains in New Jersey, near the banks of the river Hudson, has

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shrubs and trees of humble growth, but divided by extensive and fruitful vallies, and may extend in breadth about sixty or eighty miles. Beyond them to the west is a vast tract of country, said to be fertile and fine, but not much known; and though the whole of it may perhaps be held under patents from the state, it is hitherto very thinly inhabited, and the greatest part of it not at all. Lots in the town of Paterson in Jersey, of one-fourth of an acre, sell for £15.

Near Brunswick, an English gentleman gave, in the summer of 1795, £2100. for three hundred and thirty-four acres of excellent land, fit for every purpose of cultivation, or per acre £6. 5*s*. This being also in an eligible situation in every respect, was thought a reasonable purchase. A gentleman has two thousand five hundred acres in Jersey, which he lets, though with some difficulty, since so few choose to rent land, in seven farms, at a rent which he thinks pays better than at £4. per cent. but from this some deductions are to be made. Building lots in the principal streets in Philadelphia, sell at £60. per foot in front, and are from one hundred to one hundred and eighty feet in depth: before I left Philadelphia, I heard of one being sold for £72. per foot in front.

Land upon the Delaware, and the navigable waters that run into it, sell in each state for from £4. 10*s*. to £5. 12*s*. 6*d*. At two or three miles from water-carriage, at £2. 14*s*. to £3. 3*s*. These last prices I have found to hold through the greatest part of the old settled tracts of Jersey and Pennsylvania, but something lower as the situations are less convenient.

About York, among the Germans, land sells as high as £15. to £18. per acre; in the neighbourhood of Lancaster, from £12. to £15.; near the town, for £18. I saw a considerable farm, one mile and a half distant from it, that had just then been purchased at the last price; water-meadow land will sell there for £21. per acre; the industry and parsimony of these people having raised the value of land in their neighbourhood at least two hundred per cent.

The best land in Jersey, and in that part of Pennsylvania which is east of the mountains, exclusive of the German tract, may be settled at about £4. per acre: they certainly average something more than the old part of New York, this tract not being mixed with any barren mountains, and being less rocky and broken.

The back-lands of Pennsylvania sell for considerably less than those of New York: from what information I could obtain, I could not state them at more than 3*s*. or 4*s*.

lately been ascertained to be about 3,500 feet in height, above the level of the tide in the river at their foot. (*Transactions of the Society of Agriculture of New York, Vol. I. Part II. p.* 139.)

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per acre; a great quantity was upon sale for less; the tenure of them is less satisfactory than of those of New York, the titles less to be relied upon, and the whole having less credit, many egregious frauds having been committed upon purchasers, particularly those in Europe.

Very little land is let, few of the people born in the country being ever willing to become tenants, and farmers from England, who alone would be tenants of any value, are very few in number, and those, as far as I can find, in general not of a very respectable description. Custom or ignorance can alone cause this objection; since they who purchase land, purchase it with money that would otherwise afford them seven or eight per cent. at the least; whereas if they rented land, it would be at a rate that would not pay more to the owners of it, than an interest of three or four per cent.; a great gain this to the tenant, who would besides have many indulgences. So great is the difficulty of procuring regular tenants, that people here, who possess more land than they choose to occupy, or can cultivate themselves, are getting much into the way of letting it upon shares; a system which nothing but extreme poverty, or extreme ignorance, can vindicate.

This evil is rapidly increasing; an instance of this tenure I have before noticed at Boston. I have not yet heard of any in New York; but in Jersey and Pennsylvania instances are too frequent; to the south of these states I have met with none.

A country thus occupied must ever be in the worst cultivation, and both owner and occupier in a state of poverty. The terms of this tenure are various, according as agreements can be made; in some instances, the owner finds half the seed, and half the live stock, the tenant every thing else; and he has half the produce; in other instances, the owners find half the live stock, and have one-third of the produce, &c.

Want of capital in tenants, the difficulty of procuring them, and their ignorance when procured, was the cause assigned for this wretched mode of occupation; but it was observed, that under this tenure, the owner could command the mode of cultivation; and that therefore, such lands were better cultivated than others: this, however, presumes the landlord to be more intelligent than his tenant. The extent of the evils arising from this mode of occupancy, many parts of Europe sufficiently show: where-ever it is found, poverty, and the worst of cultivation attend it, as ever must be the case, where the interest of the owner and the occupier are at eternal variance; here, the owner purchases the worst of stock, because it is the cheapest, and another is to have the management of it; and the occupier bestows the least labour, because another

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is to have half the profit of it. It was scarcely to have been expected, that such a system should have crossed the Atlantic.

DELAWARE AND MARYLAND

May with propriety be joined together. The former is of small extent, and occupies only one-half of that peninsula which lies between the two great æstuaries of Delaware and Chesapeak, each side of which peninsula much resembles the other. The whole of Delaware, and the adjoining part of Maryland, is a low country, apparently the creation of waters. It has in general a tendency to sand, is not much elevated above the sea, is fertile upon the coast, but swampy and barren within land. That part of Maryland that lies upon the opposite side of the Chesapeak, is in general sandy and gravelly; in places elevated into hills generally barren; and much worn out with the cultivation of tobacco.

The farther it proceeds west, till it arrives at the mountains, the more fertile it becomes, is less sandy, and at last, about Frederick, changes to that rich, red, friable loam, before noticed in the last states, here generally lying upon a steatite or soap-rock, which in many places rises to the surface. These two states are the first in proceeding towards the south, in which Negroes abound, and in which the evils of slavery first appear, though here laying no very heavy burden upon those who are doomed to bear it; and here, slavery is rapidly giving way to emancipation. This state has no *back-lands*, and no territory of any great value west of the mountains, as in that part the Potomack, its southern boundary, and the Pennsylvania line its northern, contract within a very narrow space.

As the metropolis of the American union is now building in this state, and is to become the seat of government in the first year of the next century, a very considerable rise in the price of land, and some improvement in the cultivation, will probably soon take place.

About Dover, in Delaware, land sells for £3. 12*s.* per acre. About Bucks's tavern, £3. 18*s.* One thousand seven hundred acres, a few miles below Wilmington, were lately sold at £4. per acre. An English gentleman lately bought some on the Delaware, at £7. 4*s.* but it was supposed with mercantile views. A person has two hundred and fifty acres of excellent land near Middletown, for which he has been offered £6. per acre; he lets them for £90. per annum, and binds the tenant to cultivation, or per acre 7*s.* 2*d.*; they pay an interest of £5. 19*s.* 5*d.* per cent. On Wye river in

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Maryland, a gentleman has several thousand acres, that produce him from £18. to £24. per hundred acres, chiefly paid in wheat, or per acre 3*s.* 7*d.* to 4*s.* 9½*d.* As such land would sell on an average of £6. 12*s.* per acre, it pays an interest of from £2. 14*s.* 3½*d.* to £3. 12*s.* 7*d.* £7. 14*s.* per acre was lately offered for half an island in the Chesapeak, called Chew's Island, which contains above two thousand acres, and refused. On Bohemia river, average price of land is £4. 16*s.* some as high as £7. 10*s.*; if good wood land, which is much sought after, for at least £9. About Perry Hall, the general average of the country is £3. 6*s.* Three or four miles from Baltimore, land will sell for, from £15. to £18. per acre; and small lots, near the town, from £36. to £42.

Old worn-out land, without timber, on the Petapsco, thirty miles from Baltimore, has lately been sold at 9*s.* per acre. A gentleman has land at the back of the new city of Washington, which forty-five years since, cost £25. per hundred acres, for for which he has lately refused £30. per acre. About the upper falls of the Potomack, land, equal part of wood and clear, will sell for about £3. 12*s.* per acre. Land on each side of the Monocacy, will fetch from £3. to £4. 4*s.* per acre; a mile or two from Frederick, ten guineas; close to to the town, £18.

From the above, and many other notes taken in the state, it appears, that land here, excluding as I have before done, whatever is of increased value from mercantile situations, or the vicinity of large towns, sells at £4. 17*s.* per acre; a price considerably higher than is to be met with in any other state in the union; more land also is let, and the interest paid by it, is higher; the causes of which I shall hereafter assign, when the prices are recapitulated and collected. The result of various notes, proves the rent to be about 5*s.* per acre, and the interest paid by land, about four per cent.

VIRGINIA.

This immense country possesses every variety of soil and surface; below the falls of the rivers, that is, for the space of the tide waters, which may extend from the coast about one hundred and twenty miles, the country is very flat, apparently of late ages risen out of the sea, in many parts abounding with extensive swamps. The soil is in general a fine white sand, except on the banks of the rivers, not fertile, and much of the natural produce is cedars and pines, always indications of a poor soil. The country in general is very unhealthy, infested with fever and ague, and bilious complaints, as

may be expected from such a surface, in such a climate; and is much worn out, having been long settled, and the chief produce, tobacco. Above this, is an irregular waving country, lying for the most part in ridges, gradually falling down to the nearest rivers on each side, and high in proportion to their distance: this tract, which may extend about eighty miles inland from the head of the tide, in its original state, has not been fertile except on the banks of the waters.

Beyond this to the foot of the *blue ridge*, across, and comprehending what are called the south-west mountains, but which are only a range of hills, a step to the blue-ridge, capable of cultivation in almost every part, is a tract of the same red land before noticed, as lying to the east of the mountains: it is here of its deepest red; deep as red ochre or chalk, and with its intensity of colour, has acquired its utmost fertility. A richer district by nature there cannot be, than all those counties which lie at the eastern foot of the blue-ridge; but, like whatever on this continent has been long cultivated, they are nearly exhausted. Beyond the blue-ridge, and various other ridges lying west of it and parallel to it, are extensive vallies, from five miles to thirty in width, the plains of which are highly elevated above the sea, but lying between mountains far more elevated. The soil of these vallies is calcareous, lying every where upon a limestone, or marble, the same as constitutes the basis of the mountains, which are themselves chiefly granite, quartz, and steatite. These vallies I traversed from Carolina to Pennsylvania, in June, 1795, with infinite pleasure: it is a delightful region, refreshed with frequent showers collected on the mountains, enjoying the ventilation and cool breezes of a northern climate, with the perpetual sunshine of a southern latitude.

In a state, the soil of which varies so greatly, in climates the most desirable, as well as the most noxious to the human frame, the value of property must differ in proportion; and that it does so, will appear in stating a few instances on each side of the mountains, and then the average of each.

On the lower part of the Rappahannock, on each side of it, land, on the banks, will sell for £1. 11*s.* 6*d*; at some distance from the river, from 18*s.* to £1. 2*s.* 6*d*. On James river, below Richmond, £1. 10*s*; in a few very favourable situations as high as £4. 10*s*.; upon James river, above the falls, at £4. 10*s*. A few miles from the river £1. 10*s*. and £2. 5*s*. Upon the south-west mountains, for no where more than £2. 5*s*. The best red land in the counties of Orange, Albemarle, and Amherst, than which, none in nature is more fertile, or better adapted to clover and wheat, may be

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bought for 18s. per acre; I saw a considerable tract that had lately been purchased for 16s.

To the west of the blue-ridge. Good land in Rockbridge county, sells for £4. 10s. Land in general, including rocks and woods £1.10s. About Patten's ordinary,* for about £3. 7s. 6d. A farm, at this place, was shewn me by the proprietor, containing eleven hundred acres, one third of it cleared, and somewhat cultivated, which he had lately purchased at £2. 5s. per acre, which was thought very reasonable. (Immense tracts of all these mountains, of which one thousand acres would not be worth a shilling, and which have been neglected till within these two or three years, have been taken up by the land jobbers to sell, and are now sold, or selling in Europe.) About New-town, most excellent land for pasturage will sell for from £6. 15s. to £7. 10s. per acre. The average rate of land in the country about Winchester, from £2. 5s. to £4. 10s. in some instances, near the town, £7. 10s. Upon the Shenandoah, the usual price is £1. 11s. 6d.

To the west of the Allegany ridge, is a vast tract of back country in Virginia, lying upon the great Kanhawa river, one of the branches of the Ohio, but little known, inhabited, or cultivated, and in which the lands sell at very low prices; forty thousand acres were, in the spring of 1795, advertised in a Philadelphia paper to be sold; the terms proposed, were 7d. per acre, one quarter to be paid in hand, and the rest in two equal annual payments; other vast tracts in Virginia and Kentucky were then also upon sale, the usual price asked for which was 1s. 1½d. per acre, with considerable time allowed for making the payments.

Average to the east of the blue-ridge, £1. 19s. 8d. to the west of it £4. 3s. 10d. As far as I know, no lands are let in Virginia; therefore, there are no means by which, with tolerable accuracy, to ascertain the rate of interest for money employed in the purchase of lands.

OF THE SOUTHERN STATES

I can give little account; in all of them the land sells at a very low rate, and lower as it lies farther south.

A merchant in Philadelphia, in the summer of 1795, purchased one hundred thousand acres of land in Georgia, beginning about four miles from Augusta, the capital of the state, and lying on the road to Savannah, at 4½d. per acre.

* Inns or taverns in the country parts of Virginia, are called ordinaries.

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RECAPITULATION.

		Price per acre.			Rent per acre.			Int. paid by land.
New England - - - £	4	0	0	-		-	$3\frac{1}{2}$ per cent.
New York (old settled country) -	3	7	10	-		-	$3\frac{1}{2}$ ditto
Ditto (new country) - -	0	9	$3\frac{3}{4}$				
Jersey and Pennsylvania (old country)	4	0	0				
Ditto (new country) - - -	0	3	6				
Delaware and Maryland - - -	4	17	0	0	5	0	4 per cent.
Virginia (east of the blue-ridge) -	1	19	8				
Ditto (west of ditto) - - -	4	3	10				
Ditto west of the Allegany ridge, about	0	1	0				

Average of the old settled countries, £3. 14*s.* 9*d.*

Could the interest be stated with equal accuracy, I should apprehend it would not produce much more than three per cent. when in the hands of the tenant, though the occupier and owner are equally exempt from the payment of almost any manner of tax; but very few will rent land, and none know how to cultivate it, as will be seen, when the rotation and produce of crops are noticed.

Before the Revolution, the laws established a legal interest; in some of the states, seven per cent. in others, eight per cent. and in the southern states, I believe, more. Since the Revolution, Congress has never touched the subject of interest; and if the laws in the different states still remain in force, they are become obsolete; certainly no attention is paid to them, but every one makes the most advantage that he is able, of his money, as of any other commodity; and there are sufficient opportunities of making more than what was heretofore legal: this shews that land is little worthy of attention here, and accounts for emigrants from Europe, who, at first with European ideas, turn their attention to land, and wish to become proprietors of extensive estates, soon getting rid of their land, and employing their money on more productive speculations. *Land in America affords little pleasure or profit, and appears in a progress of continually affording less*; but it would take up too much room here, to state the foundations of these opinions.

Before I had collected, in one view, the particulars of every state, I should not have apprehended that Maryland, notwithstanding the favourable opinion I formed of

it when there, in price, rent, and interest, would have stood first in the union. This state, in climate and produce, is more nearly allied to those on the south, than on the north of it: the climate is somewhat productive of those bilious habits and complaints, so dreadfully frequent immediately to the south of it; and, as, in the south, the produce has hitherto been chiefly tobacco, which never was cultivated to the north; it has also ever abounded greatly in slaves; but it is more nearly allied to the northern states in its principles, and the liberality of its government; and to these and their consequences, this superioty must be ascribed. The body of the people may not be as well educated as those of New England, but they are fortunately uninfluenced by the wild theories of their southern neighbours: from hence it arises, that as men of property and education have the conduct of the government, it is carried on with the liberality that may be expected in such characters, and the best people of the country feel interested in the prosperity of it. Many persons of considerable opulence and extensive property reside on their estates, see to the cultivation of them, and diffuse knowledge, as far as they are informed themselves; more instances of this kind are to be met with in Maryland, than, perhaps, in any of the other states, and they have an influence of most beneficial tendency. To these causes I must attribute the superior value of property.

"*What is the price of Labour?*"

Sept. 1794. In the city of New York, seamen's wages were from £4. 10*s*. to £4. 19*s*. per month: were at £4. 1*s*. in the beginning of the summer, and at 36*s*. and 45*s*. before the war in Europe. A common labourer, as one to carry the hod, or help in clearing out a ship, 4*s*. 6*d*. per day. Carpenters, 5*s*. 7½*d*; masons and bricklayers, 6*s*. 9*d* and 7*s*. 3¾*d*.; all other mechanics and handicraftsmen, about 5*s*. 5*d*. These several last descriptions of people rarely work more than three days a week, as is usually the case with people of their class in other countries, where wages are too high.

July, 1795. Seamens' wages were then risen to £6. 15*s*. Nothing is allowed to labourers in New York city, except sometimes spirits to those who work on shipboard.

The average of the country in the state of New York, for agricultural labour, for six months from May-day, when hired by the month, 1*s*. 5*d*. per day; the other six months 1*s*. 1*d*.; if for less time, or by the day, 2*s*. may be reckoned the average of any part of the year. A foreman's wages £14. per annum; for mowing buck-wheat, or other light mowing, 2*s*. 10*d*. per day; for cradling wheat, usually one bushel of wheat per day.

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Exclusive of the above wages in money, every one in the country is provided with victuals, and in harvest expects at least a pint of rum, or other spirits a day.

Wages appear to have risen, in this state, in the proportion of four to three, or thirty-three and one-third per cent. in the last three or four years.

NEW ENGLAND.

1794, Autumn. Labourers by the month in summer per day, 2*s.*; by the month in winter, 1*s.* 3*d.*; if for a less time, or by the day, 2*s.* 7*d.* may be the average of any part of the year. Foreman in husbandry, or best working man, £18. 15*s.* per ann. Labourers on the canal of the Connecticut, from 31*s.* 6*d.* to 40*s.* 6*d.* per month, according to abilities. Carpenters and handicraftsmen about 3*s.*: the wages in harvest are usually regulated by the price of maize, a bushel of which is allowed for a day's work; this year maize being high, wages are high likewise; 3*s.* per bushel, or per day; used to be 2*s.* 3*d.* All the above labourers, exclusive of their wages, are provided with victuals, and generally with cider to drink.

NEW JERSEY AND PENNSYLVANIA.

1794, Winter. Wages in Philadelphia, much the same as in the city of New York. In the country, labourers by the month in summer per day, 2*s.*; by the month in winter per day, 1*s.* 9½*d.*; if for a less time, or by the day during any part of the year, 2*s.* 3*d.*; in hay time and harvest by the day, 3*s.* 5½*d.* Foreman £24. per annum. Labourers working by the piece at the Conawaga falls of Susquehannah, earn about 3*s.* per day, which is not too much, considering the unhealthiness of the place, and fatigue of the work.

At Elizabeth iron furnace, some of the head men have £90. per annum. All the common workmen, of which many are free blacks have £21. All the above have their victuals found them, and in hay time and harvest the workmen expect, and drink at least their pint of rum, or other spirits, a day.

Aug. 1795. Seamen's wages, in Philadelphia, were as high as £7. 17*s.* 6*d.* per month, and every ordinary seamen received it.

About the same rise of wages has taken place in these states as elsewhere before noticed.

Somewhat less difference is paid here in wages, in winter and summer, than to the north, the climate admitting of more equal labour.

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DELAWARE AND MARYLAND.

1795, Summer. White labourers by the day, at any time of the year, 1*s.* 6*d.*; free blacks ditto, about 1*s.* Labour in harvest 4*s.* 6*d.* Free blacks by the year £8. 8*s.*: hired slaves £7. 4*s.* Overseer, or head husbandman £22. 10*s.* Labourers, on the canal of the Potomack, chiefly men who have worked on the canals in Great Britain, 36*s.* per month, board, and every necessary being likewise found them, except liquors. All the above have their victuals found them; the hired slaves are also clothed.

At the city of Washington, masons, 6*s.* to 7*s.* 2½*d.* per day; carpenters, 4*s.* 9½*d.* to 6*s.*; Negro labourers (hired slaves) 36*s.* per month, board and clothes.

Baltimore mechanics, 6*s.* per day; common labourers, 4*s.* 6*d.*; seamen's wages £6. 15*s.* per month.

Little difference in the rate of wages is made in these states, between winter and summer, the climate admitting of nearly equal labour throughout the year: nor does any rise appear to have taken place in them, expect in Baltimore, where the demand for mechanical labour, in the construction of the new city of Washington, seems to have affected it considerably.

VIRGINIA.

Every thing here is performed by the labour of slaves, except on the west of the blue-ridge, where they are not numerous; there the labour of the white people may be procured, during almost any part of the year, at about 2*s.* and their victuals; where slaves are doomed to toil, the freeman holds labour to be a degradation. Virginia is in a rapid decline, brought on by her adherence to so pernicious a regimen.

The value of slave labour I have taken considerable pains to investigate and prove, but have not been able to accomplish it to my satisfaction; it is the opinion universally received there, that it is much dearer than that of freemen; but I do not find, that any one in the country, where alone it could be ascertained, have ever undertaken the subject; some say it is more expensive by one-third, others by one-half; all agree in the fact, but none can fix the amount. The price, however, paid for the *time* of a slave can be easily established, and from that we must reason upon the value of his labour. Great numbers of slaves are hired out in this state by their owners, who may be overstocked, or may not have sufficient employment for them at the time; these are frequently hired by individuals, who are in want of their labour; or by the proprietors or undertakers of public works.

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The usual price paid for a slave, employed in husbandry, is £9. per annum; he and his wife may be hired for £12.; but the person that employs them also feeds and clothes them: several hundred were employed on the canal at the falls of James river, in the summer of 1795, all of whom were hired. As these were stout able men, they were paid for at the rate of £11. 5*s.* each per annum, and their maintenance * and clothing was calculated to amount to the same sum. Suppose, therefore, that the maintenance of the slave that is employed in husbandry, bears the same proportion to the price that is paid for his time; this will make the expence of such a person £18. per annum, or per day rather more than 1*s.* 2*d.* As the climate here, as in Maryland, admits of nearly equal labour throughout the year, it may be fair to estimate it at the same rate in each state; in Maryland, it appears that the service of free blacks may be had for about 1*s.* per day, and of whites for 1*s.* 6*d.*; therefore, the time of a slave, in Virginia, is estimated at somewhat an higher price, than that of a free black in Maryland, though at less than that of a white man. But the price that is paid for the *time*, is by no means a proof of the value of the *labour* of the slave; that can only be ascertained by the actual quantity performed, and the goodness when performed; and much more may be paid for it, than actually appears. Now, nothing can be conceived more inert than a slave; his unwilling labour is discovered in every step that he takes; he moves not if he can avoid it; if the eyes of the overseer be off him, he sleeps; the ox and the horse, driven by the slave, appear to sleep also; all is listless inactivity; all motion is evidently compulsory. Any slave, that I have seen at work, does not appear to perform half as much, as a labourer in England; nor does the business, under which the master sits down contented, appear to be half, that we require to be performed by one; if to this be added the slovenly carelessness with which all business is performed by the slave, the great number of useless hands the slave owner is obliged to maintain, the total indifference to, and neglect, not say the frequent wilful destruction, of whatever is not immediately committed to his care, or within his department, and also the universal inclination to pilfering shewn by them, I cannot do otherwise than acquiesce in the received opinion of the country, that slave labour is much dearer than any other; and that the price paid for the *time* of a slave, by no means shows the amount of *the value of his labour*: it certainly is much higher than it appears to be; though

* These men were allowed half a pound of pork each, a day, and three pounds of meal of Indian corn, which last is more than they can consume, with some other little occasional indulgences; this was estimated extremely good keeping.

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not knowing the quantity of labour, performed by slaves in general in a given time, in a sufficient number of instances, I have not data whereon to calculate the exact value.

RECAPITULATION.

	per day Labour in summer.	per day Labour in winter.
In New England - -	2*s.* 0*d.*	1*s.* 3*d.*
New York - - -	1 5	1 1
New Jersey and Pennsylvania -	2 0	1 $9\frac{1}{2}$
Delaware and Maryland (white men)	1 6	1 6
Ditto free blacks, about - -	1 0	1 0
Virginia, perhaps equal to -	2 0	2 0

The average of which will be 1*s.* $7\frac{3}{4}$*d.* in summer, and 1*s.* $5\frac{1}{4}$*d.* in winter; to this must be added the price of their victuals, which I find in many instances in this country, is estimated at 9*d.* a day, except in hay time and harvest, when the workmen live something better, and have a larger allowance of spirits, or other liquors; this will raise the wages to something more than 2*s.* $4\frac{3}{4}$*d.* in summer, and 2*s.* $2\frac{1}{4}$*d.* in winter; but it is to be observed also, that as the sun sets three-quarters of an hour later, on the shortest day, at Philadelphia (which is about the centre of the union from north to south) than in London, and consequently rises as much earlier, three-quarters of an hour's labour is gained every day during the winter half year, which is a matter of no small consideration. Likewise, as it is the custom in America for all workmen, in the summer half year, to work from sunrise to sunset, and as the sun rises at Philadelphia at half past four on the longest day, an hour and a half before labour commences in England, and sets an hour and a half after it ceases, here is an additional gain of one hour and a half's labour during the other half year; from which no deductions are to be made, except that sometimes, in the very greatest heat of the weather, workmen are allowed to rest two hours in the middle of the day, instead of one as with us. This is a very great sum gained in the annual amount of labour, and leaves the difference of labour, between England and America, to stand thus:—the average of winter and summer, in America, 2*s.* $3\frac{1}{2}$*d.*: average of labour in England, 1*s.* $4\frac{3}{4}$*d.*: average of working hours in America, throughout the year, $12\frac{1}{16}$ hours; working

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hours in England, $10\frac{1}{12}$ hours; the latter hours paid by *1s.* $4\frac{3}{4}$*d.* is to the former hours, as paid by *1s.* $6\frac{1}{4}$*d.*; therefore, were the wages in America *1s.* $6\frac{1}{4}$*d.* they would be the same as in England, but being *2s.* $3\frac{1}{4}$*d.* they are *9d.* per day, or about one-fourth higher than wages were calculated to be in England, in the year 1793;* and the greatest part of this addition has only taken place within three or four years; before that time, wages were much alike in each country; and as wages in England, are very considerably risen since the calculation in 1793, I apprehend the wages, on each side of the Atlantic, are again nearly upon an equality; I suspect too, that in the climate of America, there will be fewer broken days in the year, or days entirely lost, than in England, where storms and long continued wet weather, either prevent labour, or render what is performed of little value. This refers only to agricultural labour; mechanical labour bears every where a much higher price; but with that I have nothing here to do.

The result of this inquiry is very different from what I expected, and from the generally received opinion; but, as it is a subject of so much consequence, I paid every attention to it; and it is the result of so many minutes, that I have little doubt of the accuracy of it: wherever any information was of a dubious nature, it was not at all noticed in this account. These wages are by no means of that unreasonable nature, that they should affect the prices of American produce, beyond what wages affect similar articles elsewhere; and it confirms also what I have generally heard, that in all the old settled country, there is no want of hands to perform the necessary demands of agriculture, particularly in a climate, in which wet or damps rarely occur, at a season when they would be injurious; or should they unseasonably occur, in which a brilliant sun would not soon take away their effects; this precludes the necessity of employing numerous hands; or of that expedition to which, in less favourable and more precarious climates, it necessarily is had recourse.

"*To what circumstance is it owing, that eight bushels of wheat raised by dear labour, are a profitable crop in the central states? the fact is curious.*"

With the answer to this question, the rotation and average of crops, the quantity of seed sown, and quality of the grain, are naturally connected. From the reply to the last query, it will be clear that agricultural labour is not dear, or at least not so dear as to have any material effect upon the price of the produce, beyond what labour will have in this country; nor perhaps ought it to have as much, since so little labour is

* See Young's France, Vol. I. p. 436.

bestowed upon it. As I have hitherto done, I shall divide the country into districts, according to the different descriptions and circumstances of it, and shall begin with

NEW ENGLAND.

This is a grazing country, and applicable to the rearing and feeding of cattle and sheep, producing herbage in abundance, and of excellent quality: no grain is ever exported from this district, and very little is raised in it except maize, on which, and on wheat imported from their neighbours at New York, the inhabitants chiefly depend. The plough is little resorted to, and consequently this district can afford no material information on the subject proposed; for that we must look to

NEW YORK.

This state is undoubtedly the granary of America; and if America be, or is hereafter to be the granary of Europe, that must supply by her redundancy the wants of the latter, this must be the part that must do it.

The usual course of crops in this state, is as follows: first year, maize; second, rye or wheat, succeeded immediately by buckwheat, which stands for seed; third, flax or oats, or a mixed crop; then a repetition of the same, as long as the land will bear any thing; after which it is *laid by* without seed for *old field*: or, *burn the woods*; first, wheat; second, rye; then maize for four or five years, or as long as it will grow; then *lay it by*, and begin on fresh woodland: or, burn the woods; wheat four or five years; then one or two maize, or as long as it will grow; then laid by for four or five years for old-field, without seed. A Dutchman's course on the Mohawk: first year, wheat; second, peas; third, wheat; fourth, oats or flax; fifth, maize: in his father's time, the produce of wheat used to be twenty bushels per acre; but he complained much, now that his land only produced ten bushels. The best rotation I met with, was in Dutchess county, where it much prevails: first, wheat; second and third, pasture without seed; fourth, maize, or flax, or oats, or mixed crop; in a good season this produced about fifteen bushels, more commonly twelve.

The land in this county has great inclination to produce grasses, the pasture being therefore good, and carrying, during the two years, a great stock; the succeeding crops are tolerably good also. Manure is rarely made use of; but what little is collected is given to the maize, which requires every support that can be be bestowed upon it. Maize is sown early in the spring, and stands till October or November, growing most

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of the time with great vigour; in the early part of the growth, the plough is frequently used, going first along the furrows, and then crossing them in the contrary direction; and when it is grown too strong to admit an horse among it, hand hoeing is recurred to.

By so much cultivation, the whole strength of the land is thrown into this crop, which is one cause of the wheat being so deficient in quantity; and wheat, except in new land, every where follows maize; another is, the slovenly manner in which, in this succession, it must unavoidably be sown; the wheat is sprinkled among the maize immediately before the last hoeing; and as the land is thrown up in hillocks by the horse hoeing, the crop receives much damage from the weather in winter, as well as drought in summer.

Clover is just beginning to be cultivated, in consequence of which, good pasture and plenty of hay take place of *old field*, and by the use of gypsum, astonishing crops are obtained.

A bushel of wheat or buckwheat per acre, is the usual quantity of seed; rarely either more or less, but as often one as the other. The average produce of wheat in the state of New York, has been stated to me by a very intelligent person, at twelve bushels to the acre; which agrees with the general opinion, and, I believe, is as high as it ought to be stated. The average of Dutchess county, which under proper cultivation would be a most productive, as it is a most beautiful, country, at sixteen bushels: twenty bushels are every where a great crop. The average of maize may be twenty-five bushels: above thirty is a great crop; that of buckwheat, which is very extensively cultivated, fifteen bushels. With a mode of agriculture, as before stated, it is not to be wondered at, that the produce should be so small: and it will be found that the average of this state, is superior to that of any other in the union.

How profit is to arise out of this, will now be seen; it has thus been calculated:

Rent or interest of capital, 4*s*. 6*d*.; one ploughing and harrowing, 5*s*. 7½*d*.; harvest, 4*s*. 6*d*.; seed, five pecks, 5*s*. 7½*d*.: total £1. 0*s*. 3*d*. Straw pays for the thrashing. Twelve bushels, at 4*s*. 6*d*. the usual price before the present excessive rise, £2. 14*s*. leaving a profit of £1. 13*s*. 9*d*. As by another mode of reckoning, rent or interest = one bushel, ploughing and harrowing = one and a half bushel, harvest = one, seed = one, taxes and all other small articles, = half a bushel; together, five bushels; leaving a profit of seven, which at 4*s*. 6*d*. amount to £1. 11*s*. 6*d*. This has been looked upon as sufficient profit, when it was considered that maize, not wheat, is the most profitable crop of the farm, according to the common opinion of the country.

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But I think it would be easy to prove, and it is so held by those who have paid most attention to the subject, that maize is every where a losing crop, and has been destructive to America; but it is not to our purpose here to inquire into the fact; should, however, this opinion not be well founded, the £1. 11*s*. 6*d*. above stated as profit, certainly is not nett; because the wheat and the maize must pay for their neglected waste, and also for the worn out old-field, which produces little or nothing.

Should this deduction be allowed, little profit can be found in the present mode of agriculture of this country, and I apprehend it to be a fact, that it affords *a bare subsistence*.

The quality of the wheat of this state, is the only thing that remains to be considered.

The wheat of New York is esteemed the best of any in the United States, and that grown on the banks and branches of the river Mohawk, the best in the state.

I had opportunities of examining considerable quantities of it, at Albany, in October, 1794, and found it in general of a very good quality, clean, and well dressed: the best sample that I could meet with (and which probably was as good as any that could have been produced), weighed, by the bushel that was said to accord pretty accurately with that of *Winchester*, which is the only measure of grain known upon this continent, 64$\frac{1}{4}$lbs.: this, I was informed, was the utmost weight of wheat produced in any part of America.

The standard weight is 60lbs. for all extra weight in all purchases, the grower is paid an additional price; and he deducts in proportion for all that falls short of it. It is good wheat that weighs 58 or 59lbs.

JERSEY, PENNSYLVANIA, DELAWARE, AND MARYLAND,

Have so many circumstances in common, that they may, in this instance, be taken together: except Pennsylvania, none have any *back lands*, and these have only been settled since the peace, are yet not much known, and little produce has yet come to market from them. These four states much resemble each other in the nature of their climate, and quality of their soil, and, from a long continued course of bad cultivation, are much in the same exhausted state; the crops heretofore have been in the following rotation. First year, maize; second, wheat; third, *rubbish-pasture*. By this frequent recurrence of the same crops, the land had become so far exhausted, as not to produce, upon an average, more than six bushels per acre of wheat; and much land still continues in the same course of cultivation; but an alteration has of late

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pretty generally taken place, in which one of the following rotations will be met with; first year, maize; second, wheat; third and fourth, rubbish-pasture: or first, maize; second, fallow; third, wheat; fourth, rubbish-pasture; but the fallow is stated to be so very imperfect, as to be little better than the rubbish-pasture; or in the same year with wheat, frequently buckwheat standing for seed will be met with: either of these rotations will produce eight bushels of wheat. Clover is in some places just beginning to be introduced, and is said to increase the produce of wheat at least five bushels to the acre, in some such course as the following: first, wheat; second, maize; third, wheat; fourth and fifth, clover: or first, wheat and buckwheat; second, clover; third, maize; fourth, wheat; fifth and sixth, clover, or other variations of these crops.

In the peninsula of Maryland and Delaware, which produces the beat wheat in this district, the old rotation of maize, wheat, rubbish-pasture, is still continued, and the average produce of it is thought not to exceed six bushels per acre; in some instances not more than two bushels are produced, and much is so bad as to be ploughed up again.

Not more than three pecks of wheat are sown for *corn-land wheat*; that is, wheat sown after maize, here emphatically called *corn.* From this lamentable state of ignorant cultivation, must be excepted the tract in Pennsylvania, inhabited by the Germans.

This industrious people, fortunate in possesing one of the finest parts of America, the country at the eastern foot of the mountains in Pennsylvania, have, either from superior knowledge when they arrived in the country, or superior attention to the nature of the soil and the climate, brought the cultivation of their country to a degree of excellence, which may vie with that of many of the old countries of Europe: their wheat may be averaged at eighteen bushels per acre; twenty-five bushels are frequent, and instances of thirty are not wanting; sufficient proof of what the country is capable of producing, were the culture of it well attended to. Their barns, their buildings, their meadows and pastures, are all in a style of neatness and perfection, unknown in other parts of America; by the use of gypsum they have clover, and by irrigation, meadows superior, particularly the former, to any I ever saw elsewhere, either in America or England: to them ought certainly to be given the credit of introducing irrigation into this part of America, and, I believe, the knowledge of gypsum into every part of it.

The tract, however, which they occupy, comparatively with the four states now under view, is of so small an extent, that I cannot estimate the average produce of the whole of these four states, at more than eight bushels per acre; the abundant crops of

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the Germans will not counterbalance the six bushel crops, and those of even less, of so many extensive parts of them. The profit arising from eight bushels, particularly as applicable to Maryland, has been thus calculated: rent or interest of capital, one bushel and a half; once ploughing and harrowing, one bushel; seed, one bushel; taxes, which are next to nothing, and all other little expences, half a bushel; total four bushels, leaving a profit of four; straw is reckoned to pay all expences of harvesting and thrashing, which it could not do, were it not in Maryland particularly valuable, for hay is there scarce, and all cattle are maintained in winter on straw and grain: but these four bushels cannot be fairly stated as profit; where in a three or four years rotation, fallow and rubbish-pastures intervene, their expences must be paid for by the maize and wheat. The wheat grown in this district, particularly in Maryland, though not the heaviest, is thought to make the best flour of any in the United States; the best will weigh 63 lb. and there, as in New York, 60 lb. are held to be the average, according to which purchases are made.

VIRGINIA

Is the southern limits of my information in America; beyond it inquiries were uncessary, because it appears as if agriculture had there already arrived at its lowest state of degradation.

The usual crops, in this state, are maize and wheat alternately, as long as the land will produce them tolerably well; then in future after the two crops, three or four years rubbish-pasture; and in parts where tobacco is cultivated, several crops of it are taken on first clearing the ground, before any grain is sown upon it; now and then a crop of oats intervenes, perhaps instead of wheat, perhaps following it; clover and lucern are yet little known, though there is reason for supposing that they would be as beneficial here, as the first is, in the other states, or perhaps more so; since, on account of the increasing heat of the climate, pastures and meadows are more precarious, and less frequent. Where crops of wheat, of not more than five or six bushels per acre, are expected, it is not usual to sow more than half a bushel of seed, and no where in this state more than one bushel. The average of all that part of Virginia lying east of the blue-ridge, I am satisfied I state at the utmost, at seven bushels per acre; no one states the average of all that extensive flat country in Virginia, lying below the head of the tide, at more than five or six bushels; it therefore requires much better crops in that naturally fertile, but worn out, and not extensive tract of red land, at the foot

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of the mountains, to raise the average to seven bushels. In those fertile and beautiful vallies that lie among the mountains, in which ignorant cultivators have not yet resided sufficiently long to have entirely exhausted the soil, favoured with a temperate and delightful climate, it yet produces crops equal to any in America: I have reason to believe not less than twelve bushels per acre; but the surface, capable of cultivation, when compared with the rest of Virginia, is very small indeed: with the country beyond them I am unacquainted. The average of maize, in the eastern part of Virginia, is not to be reckoned at more than fifteen bushels; of the vallies, at twenty bushels; of oats, from one and a half to two bushels of seed to the acre, will be a return of from twenty to thirty.

All the back country of America is very favourable to the growth of rye; crops, producing from twenty to thirty bushels, are commonly met with; this grain is entirely consumed in the distillation of whisky, chiefly for the consumption of the Irish frontier-men, except among the Germans in Pennsylvania, who use it for bread.

Much of the wheat of this state is of a very inferior quality, some so bad as scarcely to be of any use, though that which is good, naturally much resembles the wheat of Maryland; but the slovenly management of the farmers considerably lessens the value of it.

The use of the flail is scarce known here; almost all the wheat is trodden out in the field by horses upon the bare sandy soil, with which much of it gets incorporated, and afterwards is separated from it by sieves, or some other means that answer the purpose; the consequence of this is, that a considerable quantity of dust adheres to the surface of the grain, and insinuates itself into the groove on one side of it, so that no art can entirely clear it away; and thence I am told millers are unable to make superfine flour from Virginian wheat; and on that account, that it bears a price inferior to what the quality would otherwise demand. A weevil, or some other insect, greatly infests the wheat of this state, when in the straw, which makes it necessary to tread it out as soon as possible after harvest; and this is frequently attended with inconvenience and loss. In unloading the wheat of this state from shipboard, or otherwise working among it in the granaries, the people employed are frequently so affected with a *prickling* or *nettling* on the skin, as to be unable to go on with their work, but without being able to account for the cause of it. I recollect a similar circumstance happening, in unloading a vessel laden with Virginian wheat, some years since at Liverpool, when it was said to be caused by a minute insect. Oats are not extensively cultivated in any part of America, and are every where bad, but those of this state, of the worst

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possible quality; they have certainly kernel suffiecient to enable them to vegetate, but are, nothwithstanding, light as chaff. The cultivated oat appears again returning to the original grass. I never saw any oats that would be marketable in England, except some in the German tract in Pennsylvania, and they would admit of comparison with such only as we should esteem very moderate.

I am unable to discover how profit is to be derived from such crops, unless, that people being actually possessed of the soil, and of the slaves to cultivate it, abandoning all expectation of profit for their capital, look upon all as nett profit that is received from the land. The land owners in this state are, with few exceptions, in low circumstances; the inferior rank of them wretched in the extreme. The evils of slavery are now rapidly and forcibly recoiling from the slave upon his owner. Tobacco and maize, which heretofore have been the curse of the slaves, are now, with the slaves, allowed by all men in Virginia, to have been the ruin of themselves and their country: the almost total want of capital, among this description of people, forbids all improvement on a great scale, and want of the knowledge of agriculture, prevents its slow but certain progress. To shew what some of this land would submit to before it became exhausted, and the mode pursued to accomplish it, I will take the cultivation of a gentleman, possessing a considerable tract of land, originally as fertile as any in nature, on the foot of the Blue ridge, who complained that much of his estate was worn out. After clearing and burning the woods, seven crops of tobacco were taken, in as many years; in some instances, ten crops; four crops of wheat; and ten crops of maize and wheat alternately, in ten years. After twenty-one years, the land refused to yield any more grain; but in a twelvemonth, too benignant nature clothed his property with a matchless sheet of white clover.

To such modes of cropping, the poverty of the people, and sterility of the soil must be attributed: crops may be seen where each ear, frightened at its neighbour, keeps that awful distance, which would admit of a person's walking through the field, without breaking down a stalk, in a climate and soil well calculated for the produce of wheat. In many of the states, the Hessian fly bears the blame, which, if properly placed, ought to stand to the account of the ignorant and greedy land owner; but no one pretends to say, that this insect has committed any material (if any) depredations on this state.

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RECAPITULATION.

	Average produce of wheat.	Maize.	Buckwheat.
	Bushels.		
In the state of New York - -	12 per acre	25	15
Jersey, Pennsylvania, Delaware, Maryland	8 ditto		15
Virginia (east of the Blue ridge) -	7	15	25 oats
Ditto (west of ditto) - - -	12	20	25

The average of the above, according to the number of districts, is nine bushels and three-quarers of wheat per acre; but as the first and last district, which are the most productive, are considerably less in extent than the two which are the least productive, the average of the whole, in proportion to the extent of surface, cannot be estimated at more than nine bushels per acre; to the other crops it is not necessary to pay attention. Now, that a country situated in the finest latitudes of the globe, with a soil certainly, by nature, as capable of producing, as the climate is of bringing to maturity, far greater crops, and, certainly, in both respects, better calculated for grain than many parts of Europe, which produce from double to treble the quantity on an average, should yield crops which there, would be looked upon as scarce worth the collection, renders the cause of it deserving of our notice.

When inquiring into the subject, among the most intelligent people of the different states, I found this inferiority pretty generally attributed to a deficiency in the vegetative powers of the soil; it was said that a country, fresh out of the hands of nature, was not fertile; that it would bear a few tolerable crops when first cleared, but soon ceased to do it; and that it required the cultivation of ages, to render it as fruitful as old countries: so little were the best informed aware of their own defects, or the merits of their soil, or willing to acknowledge either of them. Some of the northern states, who remembered the days of greater fertility, attributed the visible decline to the depredations of the Hessian fly: but in Virginia, they scarcely know this insignificant animal, and therefore on it cannot cast the blame; and Virginia has probably experienced a greater failure of crops than any other state. In Virginia, this gradual decline has not injudiciously been ascribed to the culture of tobacco and maize; the

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first, it has been observed, enriched the planter, but ruined the soil; the last ruined both; but the culture of tobacco and maize, as the staple articles of the country, has only been partial, being confined to some of the southern states, while the decline has pervaded the whole of them; therefore, however injurious these may have been, we must look deeper for the root of the mischief: that I venture to state, as likely to be found in *the present constitutions of the states, and the manners of the people.*

Before the revolution, I have reason to believe that the average produce of the soil would have stood considerably higher than at present, and there is no doubt that the owners of it were more opulent: at that time, the capital of the country was vested in the lands; and the landed proprietors held the first rank in the country for opulence and for information, and in general received the best education which America, and not unfrequently Europe, could afford them; their estates were sufficiently extensive to make it worth their while to bestow their time and their money upon them; and the estates in return repaid with interest the attention and expence. The law of England * generally prevailed with respect to the descent of property; an aristocracy was formed of capitalists, well calculated for improving, cultivating, ornamenting, and enriching the country; great exertions and great improvements cannot be made in any country but by persons of this description; and no country requires such exertions and such improvements, as a *new one*. Since the revolution, a new order of things has taken place: new people, and people of very different occupations and pursuits, have taken the lead in the government, both of the confederation and respective states. The capital, as well as the government of the country, has slipped out of the hands of land owners; and these new people are now employed in very different, and, in the present state of things, more productive speculations than the cultivation of lands; in speculations frequently at variance with the best interests of the country. In some of the states, the gentlemen of landed property have passed into perfect oblivion; in none of the states do they bear the sway, or even possess their due share of influence, except perhaps in those of New England; and there, they only take it incidentally, as the lands are divided with much equality among every description of people, and are rather a secondary object, even with the principal people of the country, who generally,

* In the state of Connecticut real estates were always divided, as at present, among the children, male and female, the eldest son taking two shares; the evils, however, of minute division of real property, are there fully perceived and felt at this time.

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with a small occupancy of land, are obliged to follow other more lucrative pursuits, on which they place their chief dependence.

Before the revolution, real estates descended to the eldest son; the law, since that period, has ordained an equal division of them among *males and females* in equal degree, except in one or two states, where the eldest son takes two shares. This law has already had a very extensive, but a very mischievous, influence: it has had the effect which the authors of it intended, in introducing a greater *equality among the people*; but it has had another also, which they might not have forseen, and could not have intended; that of reducing them to *an equality of poverty, and their soil almost to a caput mortuum.* Fewer people of landed property, of any considerable opulence, are to be met with, than heretofore, and their numbers must be continually diminishing, from the influence of this law of descent; for though some people will not from custom acquiesce in it, and the wisest, from a sense of the evils arising from it, which they already feel and lament; yet the law will occasionally have its course; and the estate once divided, can never again be united. The consequence of this is, that landed property is no longer an object of profit or pleasure: few choose to possess more than is necessary for their own convenience; fewer live in the country than heretofore; no houses, in many parts of the country, of any consideration, are building; and no improvements of any kind taking place. With the decline of this class of people, and their property, is also that of the produce of the soil; for the poor and the ignorant must unavoidably wear it out; the opulent and the intelligent alone can improve and ornament their country, and increase the produce of it. Such is the operation of the new constitutions on the higher orders; and it will be found, that manners too, have their full influence on the inferior orders; the mass of those we should call planters or farmers, are ignorant, uneducated, poor, and indolent: such an one who possesses an hundred acres of ground, will not in stock, furniture, or property, be worth £60.; were he to possess such a capital, he would be esteemed a person of considerable substance; but he *boasts of his independence, and enjoys inaction.*

Of the people of this, and of inferior ranks, ease is the greatest bliss, and a *frolic* the greatest spur to activity; with such inclinations, labour will afford but a bare subsistance; and with this, such people will sit down contented rather than toil. From this picture, must be entirely excepted the people of the New England states; they, with a more rational love of independence, possess also an equal love of industry and order: consequently this exemplary and enterprising people, enjoy the natural attendants

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of such principles, knowledge, wealth, and power, in full proportion to their respective stations. The consequence of this state of things cannot be otherwise, than that the produce of the country must be stationary, if not on the decline; and that the supplies hereafter to be drawn from this, by other countries, cannot be greater, if so great, as they have been, unless some sudden and very material alteration of public principles and private practice should take place. It may account also, in part, for the excessive price which a demand not excessive, and no very great supply, has created in most articles of export from the United States, and especially within the last two or three years; and it may perhaps also appear, that this increased demand, and excessive price, have not materially added to the quantity exported * of articles of primary

* The following is an account of the export of the staple articles of the United States, in the first and last years, in which it can at this time be obtained; in the first year, public disturbances in Europe had not had any material influence on commerce; in the last, a vigorous and general war had called for all the supplies that America could afford.

Year ending Sep. 30.	Maize. Bushels.	Tobacco. Hogsheads.	Cattle.	Horses.	Rice Tierces.	Flour. Barrels.	Wheat. Bushels.	Beef. Barrels.	Pork. Barrels.
1790	2,102,137	118,460	5,406	8,628	100,845	724,623	1,124,458	44,662	24,662
1794	1,472,700	72,958	3,495	1,828	* 134,611	828,405	696,797	97,779	47,242
	— 629,437	— 32,402	— 1,911	— 6,800	+ 33,766	+ 93,782	— 427,661	+ 53,117	+ 12,780

* The return of this article being defective in 1794, that of 1793 is here taken.

The United States are therefore

Losers.

	Dollars.
By maize, at ½ dollar per bushel,	314,718,5
By tobacco, at 40 doll. per hogshd.	1,416,080
By cattle, at 20 dollars each, -	38,220
By horses, at 40 dollars each, -	272,000
Buckwheat, at 1 dollar per bushel -	427,661
	— 2,468,779,5
	+ 1,657,982,25
Dollars	— 810,697,25

Gainers.

	Dollars.
By rice, at 18 dollars per tierce, -	607,788
By flour, at 6½ dollars per barrel, -	609,583
By beef, 6¼ dollars ditto, - -	331,981,25
By pork, at 8½ dollars ditto, -	108,630
Dollars	+ 1,657,982,25

The dollar 4*s.* 6*d.* sterling.

Therefore, though a bounty from 50 to 100 per cent. has been offered on the export of their chief articles of produce, in that great increase of price that was paid for them in 1794, yet in five years the United States have declined in the value of their export to the amount of upwards of eight hundred thousand dollars, according to the peace price. The price has augmented the export of articles

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necessity to the countries demanding them, which they would have done, had the supply been naturally adequate, or capable of being forced.

" *The husbandry of every country depending mostly on the market for cattle and sheep, and wool; how far is the bad culture of America owing to a want of them? Is there a demand for beef, mutton, and wool, in any quantities for exportation or otherwise? And how far does the existence of these circumstances, in the vicinity of large towns, remedy such bad cultivatiom?*

The answer to this has, in a great degree, been anticipated in the answer to the last question; what farther is requisite, will be found in detailing the prices of articles in the different parts of the country when I was there.

1794, September. New York city. Beef, $3\frac{1}{4}\ \frac{8}{16}$*d.* to $3\frac{3}{4}\ \frac{13}{16}$*d.*; mutton, $3\frac{3}{4}\ \frac{12}{16}$*d.*; veal, $5\ \frac{4}{16}$*d.* to $5\frac{1}{2}\ \frac{8}{16}$*d.*; lamb, per quarter 2*s.*; pork, $5\ \frac{4}{16}$*d.*; pigs, live weight $2\frac{1}{4}$*d.* per lb.; butter, 1*s.* $1\frac{1}{2}$*d.*; new milk, $3\frac{1}{4}\ \frac{8}{16}$*d.* per quart; chickens, 10*d.* to 1*s.*; hay, £2. 5*s.* to £2. 16*s.* 3*d.* per ton; wheat, 5*s.* $7\frac{1}{2}$*d.*; barley, 3*s.* $11\frac{1}{4}$*d.*; maize, 2*s.* $9\frac{3}{4}$*d.*; rye, 3*s.* $1\frac{1}{2}$*d.*; oats, 1*s.* $8\frac{1}{4}$*d.* per bushel.

New York state. Beef, $3\ \frac{8}{16}$*d.*; mutton, $2\frac{3}{4}\ \frac{4}{16}$*d.*; butter, 9*d.*; wheat 5*s.* $4\ \frac{1}{16}$*d.*; pair of good oxen, five or six years old, from £13. 10*s.* to £14. 12*s.* 6*d.*; three years old, £6. 15*s.* per pair. Fat sheep which may weigh 14lb. per quarter, 6*s.* 9*d.* each; wool of good staple 4lb. per fleece, 1*s.* $5\frac{1}{2}$. per lb.

1794, October. Albany. Beef and mutton, $2\frac{3}{4}\ \frac{4}{16}$*d.*; butter, $8\frac{1}{4}\ \frac{13}{16}$*d.*; wheat, 5*s.* $9\frac{3}{4}$*d.*

1794, November. New England. Beef and mutton, $3\frac{1}{2}$*d*; butter, from $8\frac{1}{4}$*d.* to $10\frac{1}{2}$*d.*; wheat 6*s.* 9*d.*; a drove of lean cattle going into Pennsylvania to be fed, some

of chief demand by the belligerent powers, but at an immense loss in other articles, the produce of their soil, so as to leave the above great balance against the owners of it. If this be fairly stated, and the writer apprehends that the authorities from whence it is derived, cannot be disputed; surely it behoves the government of the United States to pay more attention to the landed and agricultural interests of their country; to remedy principles of law, so destructive to them; to occupy their minds on certain and immediate benefits, rather than attend to uncertain and distant speculations, before habits have become fixed in the mass of the people, which cannot afterwards, when wanted, be counteracted; before the principal people have abandoned a country life, as no longer affording them an occupation worthy of their attention; before their estates cease to be objects of rational pleasure, by being split into portions no longer worth possessing; and before they feel that their property and pursuits no longer afford them that influence, which their rank in society ought to to give them.

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of which cost £18. a pair; and when fat would weigh 1500 lb. or upwards, hide and tallow included.

About Chesterfield and Massachusets, the best sheep in the United States, weigh as high as 20 lb. per quarter, fleeces as 7 lb. each, long wool but coarse, used for combing, sells for 2*s*. 3*d*. per lb. In Rhode Island, extremely fine wool fleece, from $1\frac{3}{4}$lb. to 2lb. sells for 1*s*. $1\frac{1}{2}$*d*. per lb. unwashed; hay, £1. 10*s*. per ton.

Boston. Beef and mutton, $4\frac{1}{2}$*d*. per lb.; butter, 1*s*.; butter in barrels, from $8\frac{1}{4}$*d*. to $9\frac{3}{4}$*d*.; used to be 3*d*. and $3\frac{3}{4}$*d*.; geese, 2*s*. to 2*s*. 3*d*.; turkies and fowls, $4\frac{1}{4}$*d*. per lb. ready for the spit. Cattle for the *curing houses* in all parts of New England, in the drove, calculated at 18*s*. 9*d*. per hundred lb.; hide and tallow included. Beef from 31*s*. 6*d*. to 45*s*. per barrel of two hundred pounds nett each, according to quality; the first is very bad, the last excellent; the demand is far greater than the supply; pork per barrel, not surpassed by any in the world, 72*s*. to 76*s*.

1794, December. New York city. Wheat, 7*s*. $10\frac{1}{2}$*d*.

Philadelphia. Beef $4\frac{3}{4}$ $\frac{1}{5}$*d*. to 7 $\frac{4}{5}$*d*.; mutton and veal. $3\frac{1}{2}$ $\frac{3}{5}$*d*. to $5\frac{3}{4}$ $\frac{2}{5}$.; best flour, 38*s*. 3*d*. per barrel, of 1 cwt. 3 quarters nett; wheat 8*s*. $4\frac{3}{4}$*d*.; best Timothy hay, £3. 12*s*. pert on; maize, 2*s*. $8\frac{1}{2}$ $\frac{4}{5}$*d*. butter 9*d*. to $10\frac{3}{4}$ $\frac{1}{5}$*d*.; milk, $4\frac{3}{4}$ $\frac{1}{5}$*d*. per quart; bread of superfine inspected flour, 1lb. 7 oz. for $3\frac{1}{2}$ $\frac{2}{5}$*d*.; of inspected common, 1 lb. 8 oz. for ditto; of inspected rye, 2 lb. 3 oz. for ditto.

1795, January. Common meadow hay, £3. per ton; best Timothy, £4. 10*s*.

March. Wheat 9*s*.; flour, 47*s*. 3*d*. per barrel; fowls, 3*s*. to 4*s*. 6*d*.; ducks, 5*s*. $8\frac{3}{4}$*d*.; butter, from $10\frac{1}{4}$ $\frac{1}{5}$*d*. to 1*s*. $1\frac{4}{5}$*d*.

Prices current at Trenton, the depot for Philadelphia; wheat, 9*s*.; rye, 4*s*. $9\frac{1}{2}$ $\frac{2}{5}$*d*.; maize, 3*s*.; oats, 1*s*. $9\frac{1}{2}$ $\frac{3}{5}$*d*.; buckwheat, 2*s*. $8\frac{1}{4}$ $\frac{1}{5}$*d*.; ditto meal, 4*s*. $9\frac{1}{2}$ $\frac{3}{5}$*d*. per hundred lb.

May. Virginia, most part of the state. Beef, 2*d*; mutton, $2\frac{1}{2}$*d*.; wheat, (east of the Blue ridge) 6*s*. 9*d*.; flour, 36*s*. per barrel; maize, 1*s*. $8\frac{1}{4}$*d*. per bushel; wheat (west of the Blue ridge), 4*s*. $1\frac{1}{2}$*d*.; flour, 25*s*. $1\frac{1}{2}$*d*. per barrel; rye, 3s. $4\frac{1}{2}$*d*.; maize, 2*s*. $7\frac{1}{2}$*d*. Richmond. Beef, $4\frac{1}{2}$*d*.; mutton, 6*d*.; veal, $8\frac{1}{4}$*d*.; lamb, 5*s*. 3*d*. per quarter; wheat, 7*s*. 6*d*.; flour, 42*s*. 9*d*. per barrel.

June. Maryland, Baltimore. Beef, mutton, and veal, according to quality, from $5\frac{1}{4}$ $\frac{2}{5}$*d*. to 7 $\frac{4}{5}$*d*.; butter, 1*s*. $2\frac{1}{4}$ $\frac{2}{5}$*d*. to 1*s*. $4\frac{3}{4}$ $\frac{1}{5}$*d*.; wheat, 9*s*.; flour, 49*s*. 6*d*. per barrel.

July. Philadelphia. Wheat, 10*s*. $2\frac{1}{4}$ $\frac{4}{5}$*d*.

New Jersey. Mutton and veal, $3\frac{1}{4}\frac{3}{5}d.$; beef scarce at this season; butter, $11\frac{1}{2}d.$

New York city. Beef and mutton, $6\frac{3}{4}d.$ and $7\frac{3}{4}\frac{9}{16}d.$; veal somewhat cheaper; butter, $11\frac{3}{4}d.$ and $1s.\ 0\frac{1}{4}\frac{9}{16}d.$; wheat, $9s.\ 10d.$

From the above detail of prices, it will not only be evident, that the demand for exportation must be greater than the supply; but that the consumption of the great towns, affords a price more than sufficient for all the articles that are carried to them. A very large proportion of the supply, both for exportation, and the consumption of the large towns, is brought from very great distances; cattle from the Chenessee country on lake Ontario, and from Kentucky, into the neighbourhood of Philadelphia; the former not less than six hundred miles, the latter about seven or eight hundred. The chief part of the flour comes in barrels, from the heads of the rivers that fall into the Atlantic; and some by land carriage, from the neighbourhood of Fort Pitt to Philadelphia, a distance of three hundred miles. That a supply in itself moderate, when compared with the vast extent of country, should be collected from such great distances, is sufficient proof that the large towns have no beneficial effect on, or power to remedy, the bad cultivation of the country, even in their own vicinity.

"*It is said that all the better soils in the central states, when exhausted and left, cover themselves with white clover; ascertain the fact; and observe what soils they are, upon which this fact occurs most?*"

In every part of America, from New Hampshire to Carolina, from the sea to the mountains, the land, whether calcareous or argillaceous, whether wet or dry, whether worn out or retaining its original fertility, from the summit of the Allegany ridge to the sandy plains of Virginia, is spontaneously covered with white clover, growing frequently with a luxuriance and perfection that art can rarely equal in Europe. In the northen States, it affords an herbage throughout the year; in the southern, the seed ripens about July; after which time the heat of the sun scorches it up, and I believe it is no more seen till the spring following. The climate or soil, or both seem particularly favourable to this genus of plants; the *trifolium repens, pratense, arvense, alpestre*, are abundant, and several others are to be met with. It is probably too late now to ascertain whether white clover be a native of this, as well as the old continent.

I am told it is never met with far back in the woods, but immediately on their being cleared away, either by fire or otherwise, it takes possession of the ground; which should prove that it was natural to it; that the seed lies there, but cannot

vegetate till the ground is cleared: but again I have been told, that by some tribes of Indians it is called *white man's foot grass*; from an idea, that wherever he has trodden, it grows; which should prove at least, that it had not been known in the country longer than the *white man.*

"*Timothy produces immense crops in America: would it not be worth while to try some of the seed in England, and to sow it on the same kind of soil?*"

Timothy grass* is extensively cultivated in the middle and northern states of the American Union, and I apprehend it to be the same as the *phleum pratense*, Cat's-tail grass, of European botanists. I have frequently seen extraordinary crops of it growing thick as it could stand on the ground, 3 or 4 feet in height, and in some instances coarse as wheat straw; however, in this state, as it is cut before maturity, and as in the climate of America hay is always well cured, however succulent at the time of cutting, horses prefer it to every other kind of hay, and thrive better upon it. I cannot therefore but think it worthy of some fair experiments in this country. No other grass approaches it in produce; and it is particularly useful when mixed with red clover, in preventing it from falling too close to the ground.

"*Clover seed from America ought to be tried, particularly on ground that is tired of English or Dutch clover seed: can such be procured?*"

Clover, growing with such remarkable luxuriance as that in America, must produce good seed, and such may prove an useful change. Seed has frequently been sent from America to England; probably will be sent in future without any particular demand; and will hereafter be certainly sent, whenever ordered or required here. The price at New York in the Autumn of 1794, was about 7*d.* per lb.

* (1799). I have cultivated the American Timothy grass, and English Cat's-tail grass, in my garden for three years; and I find not the least difference between them, except that the Timothy is about a fortnight earlier than the Cat's-tail; the effect of the change of seed and climate. They are the *phleum pratense* of the variety *γ, nodosum* of Withering. This variety, I find, is not well founded, as the bulbous root is aquired both in the Timothy and Cat's tail, by luxuriant growth; and the bulbs or knots on the roots become larger and more numerous by age; young plants, and those stinted in their growth by a poor soil, have them not. The bulbous Cat's-tail, is not common in meadows, at least in this part of England; but where found, is in patches in moist rich ground, and is always productive of an heavier crop than any other part of the field: and I do not find but that cattle eat that part, as close as any other. This grass appears to thrive in the garden; but should it grow when cultivated in the field with American luxuriance, I should doubt of an English sun being able to cure the hay to American perfection.

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"*Might not Great Britain be supplied with hemp from America?*

No supply of hemp can be drawn from the United States, since the quantity grown there is very inconsiderable, near the whole of their consumption being imported from the Baltic. No country seems better calculated for hemp than the States, as far south as the southern boundary of Virginia; beyond that, the climate is too hot for it; every where to the north of this, in every waste spot, hemp grows spontaneously, with a luxuriance I never met with elsewhere: I have seen single plants upwards of ten feet in height, with branches in every direction four or five feet in length, and with a stem more than four inches in circumference. I do not mention this kind of growth as an excellence in the hemp, because such branching would be injurious to it, but to shew how congenial the climate and soil is to the plant: such excess of vegetation would be prevented in cultivation, by the closer growth of the plants.

Kalm, in his travels in America, remarks the luxuriant growth of wild hemp, particluarly about the remains of Fort Saratoga (by which I suppose he meant Fort Hardie, formerly built by the French at Saratoga); at that very place, upwards of forty years* afterwards, I saw hemp at least eight feet in height growing wild, which probably had annually shaken its seed, and annually grown from that time to the present.

Notwithstanding this natural inclination in the soil to produce hemp, next to none is cultivated; this probably arises more from the indolence of the people, than any other cause. Hemp affords much labour in the winter, on which account it would be particularly valuable to an industrious people; but here, particularly the reverse. Winter is the season of frolic and dissipation, with which nothing must interfere. These habits do not appear likely soon to be eradicated, and till that change takes place, no hemp will be cultivated. American hemp is said to be peculiarly soft, silky, and pliable; and therefore better adapted than any other, for the running rigging of ships, and it is used for that purpose in most American vessels.

Hemp is said to be much improved in its brightness and silky quality, by being rated in brackish water, which is always the case in America, when possible: experiments of that nature, might in many instances be tried in this country.

While the United States were under the dominion of Great Britain, bounties were offered for the raising and exporting of hemp, but I believe with little effect; and are at this time continued by the state of Massachusets, but with so little tendency to

* Not having Kalm's travels by me to refer to, I do not know the precise date.

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increase the culture, that the bounty for not more than one hundred tons has been claimed in a year.

" *Might not immense quantities of oil-cake for manure, and the feeding of cattle, be got from America?*"

The only oil-cake* used for manure is the residuum of rape seed, after the oil has been expressed; but as rape is a plant unknown in any part of America, though without doubt it might be cultivated there to great advantage, no oil-cake for manure can be procured from thence.

Much linseed oil is used in the United States, where the houses, mostly built of wood, are painted on the outside.

A great quantity therefore of what is called *linseed cake*, or oil-cake, being the remainder of the linseed after the oil is pressed out, might be purchased there; and would be highly useful in England, in the fattening of cattle, and for other purposes: it is chiefly consumed there by the milk-cows, in the neighbourhood of the great towns, and sometimes in fattening cattle and hogs. The present price of it in America is 40*s*. per ton; while the price of the cake here is not less at this time than £8. 8*s*.

A gentleman, in this country, aware of the advantage of importing this article from America, was lately desirous of accomplishing it; but on making the necessary enquiries, found that those cakes came under the description of one of the *non enumerated articles*, and consequently were liable to a duty, (I believe £27. 10*s*. per cent. on their value,) which amounted to an absolute prohibition. This prohibition seems

* (1799). In consequence of the above recommendation, the importation of oil-cake was allowed by 36 G. III. chap. cxiii. entiled, " An Act for allowing the importation of arrow root, from the British plantations, and also of linseed cakes and rape cakes, from any foreign country, in British built ships, owned, navigated, and registered according to law, without payment of duty." But this act has had no effect as far as relates to the importation of linseed cakes and rape cakes from America; probably from a mistake in the wording of the act, which confines the importation to British ships alone. To import arrow root, the produce of the British plantations, it is requisite, according to the navigation laws, that it should be imported in British built ships; but the oil-cakes, being the produce of foreign countries, ought, agreeable to the same navigation laws, to be allowed to be imported in the vessels of the country that produces them, as well as in British vessels; as all other importable articles, the produce of such countries, are allowed to be imported: no doubt the words, *British built ships*, where they refer to linseed cakes, and rape cakes, have been inadvertently inserted. I must therefore again recommend this article to the consideration of the Board, as the importation of linseed and rape cakes, appears an object well worth their consideration.

in good policy proper to be taken off; and I cannot do less than recommend the subject to the consideration of the Board.

" *Irrigation is much practised; the method, soils, effect, and every other circumstance should be attended to.*"

Irrigation, as far as I could learn, is known only in two parts of the United States, and in neither of them practised to any considerable extent. It offers no material circumstances worthy of imitation, nor is it conducted on any principles, that are not at this time much better understood in this country. Connecticut is the most northern state where it is met with: the practice was probably carried thither by the first settlers, most of whom emigrated from those counties in the west of England, where it is now best understood; but they do not appear to have kept pace in improvement with their kindred on this side of the Atlantic.

The German tract in Pennsylvania, is the other part where it is practised, and the knowledge was carried thither from Flanders or Germany. Two crops of hay are always cut where lands are thus artificially watered.

The law has ordained the right of the water to be in him who possesses the spring head, or the highest part of the stream; he may consume what quantity he pleases, but must convey the remainder into the ancient channel; he must not divert the stream, or waste the water to the prejudice of those below him. The mode of applying the water is different in the two states: in Connecticut it is turned on the land as soon as the weather begins to be warm in the spring; but it is not allowed to flow for more than twenty-four hours at a time; it is then taken off for a few days, then turned on again for twenty-four hours, and so on, till the meadow is nearly fit for cutting; immediately after which, it is applied again in like manner for a second crop, and then again to force the aftergrass in autumn; but it is always found to have the greatest effect upon the spring crop.

In this state they also apply water to their lands, in another very different and unusual manner; they flood great tracts of low meadows, situated on running waters, just before the winter sets in, to the depth of two or three feet, by stopping the course of the stream, and let them thus remain covered till the spring, *in order to keep them warm, and defend them from the frosts.* These lands produce the following year a considerable quantity of coarse hay; which, in consequence of the fine climate in summer, being very well got, is eagerly consumed by the cattle in winter; after the hay is cut, these fields for the remainder of the year are pastured.

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In Pennsylvania the water is usually turned on the meadows about the middle of April, and is allowed to flow about two months; a few days after which, the ground having got dry, the crop is cut: as soon as the crop is off, the water is again turned on for three or four weeks, or till the land gets a sufficient covering to defend itself from the sun, at that season very powerful; a second crop is then soon ready for the scythe; after which the water is allowed again to flow over it, till within a short time before it is wanted for pasturage, when it is turned off, in order that the ground may so harden as not to receive injury from the treading of cattle. Which of the two methods of applying the water may be most productive, I know not, not having seen the meadows of Connecticut in the summer season; but those of Pennsylvania bear abundant crops.

Water issuing from limestone in Pennsylvania, is thought preferable to any other running stream; but the warm half putrid water from a reservoir made for this purpose, which is not unfrequent, or a mill dam, in which it becomes soft, slimy, and muddy, is greatly preferred to all others; water of this kind, at this season of the year, will in Pennsylvania be heated as high as 85° by Fharenheit's thermometer, and must have a great effect in forcing vegetation.

No art is used in conveying the water beyond a channel, carried on a level as far as it can be done conveniently, over one side of which it can flow: no means have been taken for raising it above its natural level, which in many places might be performed with much facility.

Since the introduction of clover, these meadows are falling fast into disuse, many of them having been already ploughed up and converted into tillage; no farther improvements are therefore hereafter to be looked for in this branch of rural economy.

" *To examine how far, to what cause owing, and the effects of an indigent poor in the United States, is an object of great political importance, and whether such are ready to emigrate to, or beyond the mountains?*"

There are no indigent poor in the United States. In a country, where in every part the demand for labour greatly exceeds the supply, where wages are high, and provisions not in proportion to them, no one can want, that will labour; and the able, who refuse to work, will there meet with no support. In the country, I never heard of poor; in the great towns, there is a reception for such as want it; in which are a few people, chiefly negroes and foreigners, whom the accidents to which the lower classes are liable in a town, or the diseases of a new climate, compel here to seek

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a refuge. These poorhouses are either maintained by a tax on the inhabitants, or more generally by the corporation of the town, or by the state.

None emigrate to the frontiers beyond the mountains, except culprits, or savage back-wood's men, chiefly of Irish descent. This line of frontier-men, a race possessing all the vices of civilized and savage life, without the virtues of either; affording the singular spectacle of a race, seeking, and voluntarily sinking into barbarism, out of a state of civilized life; the outcasts of the world, and the disgrace of it; are to be met with, on the western frontiers from Pennsylvania, inclusive to the farthest south.

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VI.

Account of some interesting Experiments, on the various Modes of raising Turnips. *By* Mr. W. Jobson.

Sir,

My father was duly honoured with the thanks of the Board of Agriculture, for a paper sent by him on the subject of fallows and grass lands, together with your letter of the 5th of March, expressing a wish to have an account of our experiment on the culture of turnips, transmitted to the Board.

I am sorry that it is not in my power to furnish you with such an accurate statement of the whole experiment, as I could wish; but if you think there is any information to be gained from the trials we have made, you are at liberty to present the account thereof to the Board.

The paper I herewith inclose, contains the weight of six parcels of turnips, which were part of a field of fifteen acres, sown in the month of June, 1797, for the purpose of ascertaining the comparative value between the drilled, and broad-cast method. The whole field was in equal tilth, was manured as equally as possible, immediately before sowing, with rotted fold yard dung, at the rate of seventeen cart loads per acre, each load containing about twenty-eight Winchester bushels; and in order to make the experiment perfectly fair, there were breadths of land of twenty yards each, sown in broad-cast and drills alternately, throughout the whole field; part of the drills on one-bout ridges of twenty-seven inches each, with the dung laid immediately underneath where the row of seed was deposited; the rest of the drills upon a level surface, were sown by Mr. Bailey's machine, at twenty-one inches distance. The produce per acre is calculated from the weight of four square perches, or the fortieth part of a statute acre of each, having first cut off the tails, or fibrous part of the root, and thrown them aside, as unfit for food, and then taken the weight of the tops and roots separately.

It is necessary to observe, that this field of turnips was but a middling crop, having been much hurt, immediately after the first hoeing, by the grub (a small worm which destroys the tap root); particularly the drilled part of the field, which, having had the

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plants set out, at the distances at which they were intended to remain, before the grub seized them, was on that account rendered too thin, and otherwise much injured; notwithstanding which, it was found that those on the one-bout ridges, exceeded the others in weight: also, that these parcels of turnips were taken from an inferior (though not the worst part of the field), and may therefore be deemed to be a pretty fair average of the whole: there were also three other portions weighed which were taken from a part of the field where the roots were larger, and a fuller crop, with a view to ascertain what might have been expected, had not the grub seized them in the manner described; but unfortunately, the paper containing their weight has been lost or mislaid, which puts it out of my power to furnish you with it. There was also an account taken of the number (but not the weight) of loads, which were produced upon a few acres of the worst part of the field, which was in favour of the broad-cast, in the proportion of ten of broad-cast, to nine of those drills on one-bout ridges, and eight of Mr. Bailey's drill.

From this experiment (though defective from the reasons assigned), we have reason to conjecture, though not to form a conclusion, that a heavier crop *may* be raised by sowing in drills, at twenty-seven inches distance, with the dung immediately beneath the plants, than in broad-cast, or in drills at twenty-one inches on a level surface; but whether the advantage arises from the situation in which the dung is deposited, or from their having a freer circulation of air, or from both these united, it remains for future and repeated experiments to decide. Notwithstanding this, it will be found that each of these methods possess peculiar advantages, and disadvantages, according to situations and circumstances; the reasons for which I deduce from the observations I have made respecting this, as well as former crops. In the first place, the one-bout ridges, I think preferable for early sowing, and eating off, through the winter months, even so late as the month of February, as they are more easily procured for food for cattle in deep snows; also, in situations where it is difficult to procure a sufficient number of experienced hoers. Those under the drill system can be more easily managed, and at less expence, as boys and girls may be readily taught to set out the plants with great regularity in very little time; but turnips, under this system, are liable to the inconvenience of being more apt to be injured by severe frosts, from their high exposure. Another inconvenience I have also observed on wet and heavy lands, more especially with little declivity, that although there should, and possibly may, be a larger crop produced thereby, yet the land will unavoidably be so much poached by

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carrying them off, that the succeeding crop of corn will be lessened, more than the extra value of the turnips will compensate. When it is attempted to raise turnips upon land of this description, it will be found more advantageous to form it into ridges of sufficient height, to carry off the water with ease into the water furrows, and of sufficient breadth (suppose fifteen feet) to allow a cart to pass along them freely, without forcing the earth in, to choke up these furrows. The turnips may be sown either broad-cast, or in drills, upon the surface of these ridges. If the land is addicted to annual weeds, they will be best in drills, which will expedite the hoeing; but if not, or if they be late in sowing, or if the land be subject to the grub, broad-cast will generally be found to produce a more certain crop, as they can be left so near to each other at the first hoeing, as to admit of being thinned, and thereby gives the opportunity of taking out unhealthy plants at the subsequent hoeings; and also, that they grow more vigourously between the first and second hoeings; which I attribute partly to the broad-cast plants sheltering each other more, and partly to the earth being so much loosened near the plants in the drills, when they are cleaned by the plough or horse-hoe, before the tap root has got a sufficient hold to support them.

Wishing the Board success in its endeavours to promote the science of Agriculture,

I remain, with respect,

your obedient servant

W. JOBSON.

Turvelaws,
April 5th, 1798.

P. S. I am sorry that I have not been able to collect the information you wanted, respecting the short-horned breed of cattle. The queries are of such a nature, as to require more time and attention that I have yet had an opportunity of bestowing on the subject, to give satisfactory answers to them; I shall however take them under consideration, and let you know when I can send them.

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Comparative Weight of six Portions of Turnips, which were part of a Field of fifteen Acres, at Turvelaws; the whole of which was sown in the month of June, 1797, as an experiment between the Drill and Broad-cast Systems.

	Time of weighing.	No. upon 4 square perches.	Weight on 4 square perches, or the 40th part of an acre.						Weight per statute acre.				Average weight of each turnip.		Average distance of each turnip.
			Roots.			Tops.									
			cwt.	qr.	lb.	cwt.	qr.	lb.	tons.	cwt.	qr.	lb.	lb.	oz.	
No. 1. Drilled on one-bout ridges, at 27 inches distance - - -	January	354	8	1	1	1	1	3	19	1	0	20	3	0¼	16½ in. by 27 in.
2. Drilled with Mr. Bailey's machine on a level surface, at 21 inches distance -	ditto	428	7	1	15¼	1	1	5¾	17	7	1	8	2	4¾	17 in. by 21
3. Broad-cast - - - -	ditto	568	7	2	12½	1	0	11¾	17	8	1	26	1	11½	16¼ each way.
4. Drilled on one-bout ridges, at 27 inches distance - - -	March 2d.	334	8	3	0	1	1	22	20	7	3	12	3	6¾	17 by 27
5. Broad-cast (these and the preceding were round white turnips) - -	ditto	628	8	2	22	1	1	8	20	0	2	24	1	12½	16 each way.
6. Broad-cast (red) - -	ditto	561	6	3	26½	2	3	5	19	11	1	0	1	15¾	16½ ditto.

By noting the average distance of each turnip, as is done in the last column, is intended to shew at one view how many plants there were wanting in the drills to have made them a full crop; for, if 550 be stated as a medium number in a full crop, upon the 40th part of an acre, they will be found to occupy a space of 17 inches each way in broad-cast, 10½ by 27 inches on the one-bout ridges, and 13½ by 21 inches of those drilled on the level surface; from whence may be easily seen, how much those were wider in the rows, than they ought to have been.

VII.

Account of Herefordshire Breeds of Sheep, Cattle, Horses, and Hogs.

By T. A. Knight, *Esq. of* Elton, *near* Ludlow.

SHEEP.

The common breed in my neighbourhood in the north-west part of the county, are a black-faced horned breed, with moderately fine wool, worth at present (November 1797,) about 19*s.* per stone of $12\frac{1}{2}$ lb.; they are much improved by crossing with the South Down.

The breed may be described as to the following particulars; namely,

Form, something similar to the South Down, but inferior; colour, black-faced, generally horned; flesh, superior to most in the Island; tallow, yielding on a fair medium, seven pounds in a wether of 13 lb. a quarter; and this in the wethers is the usual weight of the different quarters, and 9 or 10 lb. in the ewes.

In respect to the number kept per acre, our sheep being very properly confined to barren hilly pastures, three are as many as an acre of such ground will maintain; folding is not in use; time of lambing in March; wool, as before noted, moderately fine.

The price of a lean wether of 13 lb. per quarter, when fat, 18*s.* or 20*s.*

Varieties of the same breed occupy the north-west part of Herefordshire, and the adjoining parts of Shropshire, extending far into that county. I do not know any breeder who is much celebrated, nor am I acquainted with any instances of extraordinary individuals.

As reasons for crossing, I am of opinion that it always improves, when the breeds are of similar kinds: and those farmers have the worst flocks who breed from rams on their own farms; a sign of breeds degenerating, if not crossed.

Our sheep feed during the summer, on the commons or barren hilly pastures; and the wethers, when three years old or upwards, generally find means to subsist on the same pastures during the winter, except in deep snows, when some hay is occasionally given; but they are most frequently turned into a wood or rough pasture, over-grown with bushes, to shift for themselves. The breed is extremely hardy.

The ground is generally too poor for crops of cabbage, and the country too late and

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cold in the north-west part of the county for stubble turnips. Turnip-cabbage, burnet, rape, not used; winter tares have been lately, with much advantage, kept; grass is sometimes used, but ray-grass being esteemed injurious to succeeding crops of corn, is very seldom used.

No ponds are made for sheep to drink at, nor are sheep, to my knowledge, ever soiled or stall-fed.

Dry soils are always best for sheep; though it is not possible to judge from external appearances, whether sheep will succeed well or not. When they are kept in inclosures, I would never wish to suffer them to feed on pasture which would support more than four an acre, during the summer. No oil-cake is given to the wethers to fatten them. I think the best sized inclosures for fatting, or keeping sheep, are small fields, with frequent change, as they thus feed much the best.

As to the sort of stock kept, breeding stock, lean wethers, fatting wethers, and suckling lambs, are mixed on most farms, where sheep do not rot; but do not usually graze the same pastures together, except in the middle of the summer.

Rams decline in their vigour after the age of five or six; they are never let to hire. When ram-lambs are castrated, that operation is performed on them as young as possible.

I know of no composition for marking, not injurious to the wool, except red ochre.

Our sheep are generally put to fatten at three or four years old; but on commons, those are drafted out which are least strong, in spring and autumn. I have purchased several as old as thirteen. I have observed that wethers of about 13 or 14 lb. per quarter, of the breed in my neighbourhood, succeed better on the most barren pastures, than those which are less or larger.

The proportion betwen the weight alive, and the dead profitable weight, may be thus estimated: in a sheep of this breed under 12 lb. per quarter, the weight alive is more than double that of the four quarters when the sheep is cut up, particularly if the animal be very old; in larger sheep, the four quarters are more than half the weight of the living sheep.

No shepherds are kept in Herefordshire.

On some pastures, sheep, though brought on rotten, will live and thrive, but whether the liver ever becomes sound or not, I cannot say: the butcher's knife is the common cure. The red-water is little known, if at all; nor has the foot-rot been observed in this

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county, that I know of, except among a cross of the Spanish breed: I am not acquainted with any mode of curing it. The scab is very common, and cured only with mercury: the rickets are not known. In curing the fly, nothing more is done than cutting the whole very close on the affected part, and rubbing it with wood-ashes: the flux, hoving, and the blood, are little known; but sheep are always blooded when they are in high condition, in the autumn: no disease known under the name of the gall: salt is rarely given, and then without judgment: ewes very seldom slip their lambs in this country.

The annual expences on a flock of a given number of sheep must vary much, on account of the size of the sheep, the value of the ground, season, &c. I suspect that the Archenfield (fine woolled) breed, of which I shall speak in another place, are made to live on less food than any other in the Island. Good lambs are rarely sold; the produce of wool is 2 lb. from an ewe, and 3 lb. from a wether, worth about 19*s.* per stone, of $12\frac{1}{2}$ lb.; old ewes are worth from ten to fifteen pounds a score.

The only stock which are folded in my neighbourhood, are Lord Bateman's, the North Wiltshire breed, which are in my estimation the worst breed in the whole county: his Lordship's farm is, however, under excellent management. I cannot say what is the loss in hurt to the stock by folding, reckoned per head per annum of the ewes, or of the lambs. In regard to the difference in the product and value of pasturage, from which sheep have, and have not been folded, I would observe, that sheep which are folded at night, must have a good pasture by day, and the Herefordshire farmers have too many cattle to afford them one. Cotting is used with the Archenfield breed only; no plantations are formed for the sake of shelter.

The Archenfield, or proper Herefordshire breed, are small, white-faced, and hornless; eminent for the fineness of their wool, and extremely patient of hunger. Nothing occurs in the management of them worthy of notice, except the custom of cotting them during the winter. This custom would be found beneficial to ewes and lambs of every breed, whilst the lambs are young: they are sheared by women, each shearing about twenty, and once only a year. The average weight of an ewe's fleece is about 2lb.; of a wether, 3lb. or more; some of the largest wethers in the southern part of the county will yield nearly 5 lb. each, (and it may be questioned whether these are of the true Archenfield breed,) value 2*s.* per lb.; no trials have been made in cloathing sheep. The wool being sold soon after shorn, it is the wool dealer's business rather than the farmer's, to ascertain the best means of keeping it: the oil it contains may

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probably preserve it many years; the farmers suppose it always to gain weight. It is sold by the stone of $12\frac{1}{2}$ lb. principally at Hereford and Ross fairs, and manufactured into the finest broad-cloth, in mixture with Spanish wool.

Very little is spun or woven in the county, unless of the black wool by the poor: carding and combing is rarely done for hire; I am ignorant of the expence of working up a pack.

The number of sheep kept in my neighbourhood is less than formerly, but I am unacquainted with their amount. The adjacent mountains of Wales have not had more than half their former stock, during the last six or seven years: no encouragement have been given by societies, or individuals, by premiums or otherwise, to improve the breed; though some individuals have paid much attention to their improvement, and I think with much success; but as they always make their sheep live on very little, they have not increased their size: their forms often reach my ideas of perfection. The Archenfield breed require attention in winter, being very patient of hunger, but not of cold; at least I have found that they suffer much after dropping their lambs, if not protected by the cot. No other smearing is used than red ochre; or, in the north-west part of the county, the earth which has been rendered red by burning at the limekilns, with a little grease: it is supposed to thicken the fleece, and it protects the newly shorn sheep from the weather.

The effect of occasionally laying down arable lands to grass, is always beneficial.

The arable lands of Herefordshire seldom lie more than two years, with clover and trefoil, and ray-grass; but ray-grass is not much approved, and is supposed to be an *exhauster*; and I believe with *reason*, if the ground be afterwards sown with blade-corn: not that I suppose this plant takes more nourishment from the ground than many others; but merely that, being of the same tribe of plants with the blade-corn, the ground does not experience the same beneficial change of crop, as with clover and trefoil.

I am unable to state the weight of mutton that will be added to lean sheep, of a given age, by an acre of grass, of clover, or of turnips; the produce of an acre of grass or turnips being so very various, as the weather is wet or dry, and the quality good or bad. Much will also depend on the state of the weather during the time the crop is eating off.

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CATTLE.

In the north-west part of Herefordshire, many long-horned cattle are kept; but they are yielding rapidly, and justly, to the breed properly called the Herefordshire. Some branches of the Herefordshire breed suit the dairy; but as a breed, it is most eminent for work and fatting. Frequent crosses are made between different families of the same breed, but never with the long-horned breeds. The long-horned breed is much less patient in the yoke, and much less capable of bearing heat.

The Herefordshire colour is a deep red, with a white face; the horn of moderate length; the flesh preferred by the butchers to that of the long-horned breeds; the quantity of tallow depending on the number of months the animal has been feeding; the hide very thin; the weight of oxen, upwards of thirty-five stone a quarter the largest; the price thirty guineas and upwards for the best oxen when half fatted; varying according to seasons and times; price, twenty guineas about the average for good oxen; these in figure perfectly well calculated for beasts of labour. Calves are generally desired soon after Chirstmas; but when the dairy is much thought of, the end of February is early enough. Calves, however, which come early, always make the best cattle.

The Herefordshire breeders seem unanimously agreed, that a very large cow, however well formed and perfect in every respect, rarely produces a good ox; and they therefore justly disregard the weight and intrinsic value of their cows, reckoning those the best, which experience has taught them are best calculated to produce good oxen. Hence it has followed, that the Herefordshire ox is a very superior animal to the cow, after attaining double the weight. I do not however admit, but that this county can shew as beautiful cows as any in the Island; but it is the ox on which it prides itself, and stands, I am confident, without a rival: for whilst I admit the merit of the Sussex and Devonshire breeds, I consider the Herefordshire as the first breed in the Island. And such is the opinion of a gentleman, who has taken much pains to make himself acquainted with the different breeds, and has described their merits and defects with equal judgment and impartiality: I mean Mr. Marshall. I have seen many good cows of the long-horned breeds, but never one good ox.

The largest ox Herefordshire I believe ever produced, was shewn in London about two years ago. A cow was killed at Hereford about four years since, which I was informed weighed thirty stone a quarter. When breed are not crossed, all, who have

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tried the experiment, assert that the cattle become less on the same pasture. The Herefordshire breed is in so many hands, and has been so long and so generally attended to, that every part of the country affords eminent breeds, and wants at present no encouragement; as it is spreading rapidly in every direction.

In describing the manner in which cattle are fed through the year, I would observe, that in *summer*, meadows, when not mowed for hay, are depastured with the calves during the first year, and with milking cows and feeding oxen. The after-grass is applied for the same purposes in the autumn. The upland, or rough pastures, maintain the young stock and labouring oxen: clover, tares, lucerne, sainfoin, and chicory, are never used. In *winter*, hay is given to the cows and yearling calves, as is straw for the labouring oxen and young stock, with turnips; but chaff is not used, nor are corn or oil-cakes, except to fatten. Cabbages, potatoes, carrots, and linseed, are never given; kept grass sometimes is, thought but rarely: the best farmers always provide turnips for young stock, as well as for feeding cattle; but the young stock of this county is in general ill fed during the winter, and indeed not very well at any time.

In proportioning each sort of food necessary for wintering a beast of a given weight, it is hardly possible to speak with accuracy; and winters which are long and severe, will require much more food than mild ones of course. In *spring*, neither cabbages, winter tares, or rape, are used; ray-grass not very uncommon in rich ground, where meadows do not abound; very little kept grass.

Turnips (the only green food given during the winter) are always drawn and carted off the field, little of the land bearing to be much trodden; and the effect of this food is, that they always appear to benefit young stock, more than any food which has yet been tried.

Herefordshire is rather a rearing, than a feeding country, and no particular form of stalls are in general use: fatting beasts are usually kept cool; but I suspect moderate warmth in the earlier stages of feeding, would be found very beneficial: young stock are never kept warm enough.

No weighing machines have been used, for ascertaining how much beasts gain or lose on certain sorts of food; nor is it easy to say what weight of beef will be added to a lean ox, by an acre of grass, of turnips, &c. or by a ton of oil-cake, as much must depend on the merits of the animal. Small inclosures for feeding cows, and fatting cattle with frequent change, are most certainly best.

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Heifers are sent to the bull at two years and a half old; oxen which have been worked, are sold to be fatted at five; cows continue profitable milkers, from twelve to sixteen.

In respect to fattening an ox of a given weight, much more depends on the disposition to fatten, than on the weight. Many of the oxen which are sold by the Herefordshire farmers, are half fat, but few wholly so; and never fed without much loss to the farmer. I am ignorant of the proportion between the weight alive, and the dead profitable weight; as I also am of the weight and value of the hide; though it is much less than that of a long-horned beast of equal size.

Our steers are put to work at three years old, and are worked two years, generally in yokes; but harness has been lately tried, being approved of by some, and disapproved of by others; it is, however, becoming more common, and bids fair to come into general use. They usually work six or eight in a team, in yokes, and plough something less than a statute acre. In adverting to the comparative advantages and disadvantages of using horses or oxen, I am of opinion, that where a farmer has a quantity of rough pasture, and has ground on which oxen can work without injury to it, the advantages are considerable, as they consume no corn and little hay, and improve in value annually; but unless a farm be large enough to employ a horse team, as well as oxen, they cannot be used with advantage; as they are not well calculated for all kinds of work. Oxen rarely go on hard roads, at present, and are therefore very rarely shod; they were formerly always thrown down, and not unfrequently injured in being shod.

A bull usually shews most vigour at one year old; and more energy may be expected in the produce, than from one full aged: they become languid at four or five, but generally learn to break the fences, or become ungovernable, at two or three; and are therefore usually killed at that age.

The most common disease incident to cattle is, I believe, the discharge of red or black urine, and this is sometimes fatal.

I cannot speak with any degree of accuracy, as to the annual expences of my dairy; as I always change the pasture of my cows frequently, and graze the pasture after them with other stock, generally horses. The quantity of milk obtained from the best breed is small, perhaps about eight quarts each meal; but the quality is generally extremely good: the quantity used for a pound of butter or a pound of cheese, varies according to the nature of the pasture. The method of making cheese has nothing worthy of

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imitation, there being nothing peculiar in the Herefordshire dairy management. The curd is not scalded, but broken, in the Cheshire manner: the soil of this county is not in general well adapted to cheese making. The quantity of butter produced per cow, is 4 or 5 lb. a week in summer, where no cheese is made; the price 10*d.* to 1*s.* lately; that of cheese, 5*d.* the pound.

I do not know any article more affected by the pasture than cheese, both in quantity and quality. I have observed in the best Cheshire pastures, that the crested dogs-tail, with white clover, was the most abundant herbage. I have no reason to suppose the quality of the cheese, or its quantity, depended on the kind of plants.

No improvements have been made in the structure of churns or cheese presses, nor are there any particular modes of preparing milk in my neighbourhood.

Our calves are weaned at three months, or older, if calved early, with no food but grass. No trials have been made to rear them without milk; but milk from which the cream has been taken, is often given.

Concerning land being laid to grass to stock with cattle, or grass which supported cattle, being ploughed up: I think the quantity of tillage nearly as great as it was 20 or 30 years ago, in some parts of the county, but in others, the tillage has lessened, and was certainly growing less, before the excessive high price of corn took place. Good tillage has certainly much decreased, and is now decreasing; for whenever the farmer and the tythe-man quarrel (and they very often do), the former converts any land which will bear grass, to pasture, and in that it generally remains.

HORSES.

The breed in my neighbourhood is a mixture of all kinds, and all bad; bred at home, and not purchased; the price £8. £10. or £12.; sometimes £20. or more. In the food and management of colts, there is nothing worthy of imitation or mention.

The number of horses to 100 acres of arable, is five with oxen, or eight without: a breeding mare may do about half the work of a horse, without injury.

I have never calculated the annual expence of keeping a farm horse in oats, hay, straw, summer food, farrier, and shoeing, separately; but I consider the expence of each horse not to be less than 6*s.* a week, when they work. The cheapest, and I think the best food for a working horse, is ground beans, mixed with a very large quantity of cut straw.

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The annual decrease of value in a horse, must depend on the usage the horse receives. One worth £20. at six years old, probably declines about a pound a year, during the first six or seven years, and more afterwards.

Three acres of very good grass land, or of clover, are sufficient for the consumption of a waggon horse; but not less than five or six of such as horses are fed on in this country; some corn being also given. Clover is the common food, both for summer and winter: it is rarely cut for them in summer, but it always should be: oats and beans are generally given whole; but I have found that a much smaller quantity is wanted, when they are well ground. I do not know of any experiment having been made to lessen the expense of feeding, on potatoes, carrots, rutabaga, or turnips: bruised whyns or furze have been tried on a small scale. In a case of necessity I saw it given, and the horses did much better than I could have conceived possible on such food.

We have no prevalent distempers: a cart-horse will last till about 20 years old on an average, when well used. Some of our best farmers keep their horses in the yard almost all the year. Soiling is practised, on tares frequently, and the practice gains ground; on clover, rarely; never on chicory, grass, or lucerne. Sainfoin will not grow; it has been tried by myself and others. As dung of every kind is thrown together, I cannot say what is the annual value of the manure made by a horse.

HOGS.

The breeds of hogs in my neighbourhood are various; the Shropshire, the Herefordshire, and the Berkshire: the two former, large breeds; the third, less than either, but more compact. Crosses between the large breeds of the country, and the Chinese and Berkshire, have been tried, and in my opinion, with injury to the feeder and consumer; for I am confident the largest animal of this species, generally speaking, pays the breeder best, as well as the community; for the difference between the living and the dead profitable weight, is always least in the largest animal; and therefore the bones in those whose forms and merits are alike, being in proportion to the living weight, are of course proportionably least in the largest animal. The skin is also less wide; and as the meat when cured has less external suface, it is cured with less loss. The breed of hogs near the county-town are generally bad, though large; but many of those in the north-west part of the county are extremely good.

Hogs are much fed on clover and green vetches, an excellent food, crops of which have lately been raised on purpose for them: the latter crop much increasing.

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The smaller breeds produce pigs earlier than the larger ones; the average litter from 12 to 16 of the small breeds, and 8 to 12 of the large. The Chinese breed is the most prolific, bringing three litters sometimes in twelve months: much must depend on the quantity and quality of the food given: they are always fatted with peas. Clover, grass, and milk whey (of course) much used in summer; lucerne, chicory, and parsley, are unknown. In winter, pease and some beans, with a few boiled turnips, and potatoes, both raw and boiled, are given them, with whatever the dairy yields: cabbage, carrots, and rutabaga, are not grown. It is to be observed, that few beans are raised in this county, but large quantities might, and ought to be planted.

Clover is rarely, or never depastured with hogs solely, so that it is difficult to say what quantity an acre would carry. Trials have been made on soiling hogs with green tares, and with the greatest possible success. They should never be put to fatten when lean: one in a good condition, which when fat will weigh 20 score, will eat six or seven bushels of pease. I know of no difference observed in fatting, from the quality of the straw given for litter. I always use bean halm.

As to the weight of pork gained in fatting, by given a quarter of pease or beans, 20 bushels of potatoes, &c.; much must depend on the size and breed of the hog. Judging from the value before and after fed, I suppose a Winchester bushel of pease will add about 9 or 10 lb. to the weight of a good hog of 20 score; perhaps something more on a larger, and I suspect a good deal less on one of a small size.

Winter-wash is not heated to be given them, nor have trials, that I know of, been made on keeping their food, purposely, till sour. Brewers' grains are preserved for use, by mixing them with a quantity of sour wash, sufficient to prevent their heating. Hogs of different sizes should never be confined or fed together.

As small hogs sold last year, the product of a good sow was worth £30. per annum, at the time of weaning: at present, it may be worth about a third of that sum. I cannot say what quantity, nor estimate the value of manure, a sow will make in a year. Almost every farmer has to calculate the damage done by his breeding sows, in his corn and orchards.

No instances of extraordinary individuals have come under my own observation.

As to the stock of pigs that one flail will feed by the corn that is turned out of the barn in the straw, hogs never trust solely to that for subsistence; I should think a single one would fare ill.

I have never known any thing like an epidemic disease among hogs.

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The difference of proportion between the live and dead weight of fat hogs of different sizes, is least where the animal is largest; but I do not know the proportion in any size: it is certainly much less than in any other animal.

No trials have been made in tanning and using their hides, except when they die by accident or disease; nor do I believe any trials have been made in folding them in the manner of sheep folding.

HINTS ON GRAZING,

In Answer to Mr. PRICE's *Queries.*

The soils of Herefordshire are extremely various, but the prevailing kind is a strong tenacious loam on the surface, and a subsoil nearly similar, but of greater strength and tenacity, with a small portion of calcareous earth, in many instances. On the higher grounds, the soils are more light in quality, and shallower; on sand stone, or limestone: the latter calcined is used on all kinds, and with success; but it has (as far as I have had opportunities of observing) the least good effect on wet soils, and on those which rest on limestone basis.

From the nature of its soils, Herefordshire suffers more from excess of moisture, than from drought, except in the ryeland (southern) parts. The wheat is in consequence generally sown on small ridges, each forming a segment of about $\frac{1}{5}$ of a circle, or something less. The ridges are formed with more neatness than I have ever seen in any other county. This praise is not, however, due to every part of the county, nor to all the farmers in any part. From the impervious nature of the subsoil, many surface drains are wanted, and usually made. There is, I believe, nothing peculiarly deserving notice in the manner of applying covered drains. In my own practice, I have first tried the ground by boring, and then have cut my drains across the higher ground, from which the moisture came, putting the drains so near, that the top of the lower, lay one foot higher than the bottom of the one immediately above; and boring nine or ten feet deep every seven yards in the bottom of the drain, to open a communication with any spring which may lie beneath. When the field is nearly flat, the drains are few and distant; but where the descent is rapid, numerous drains are necessary. A yard is the usual depth, but I have generally sunk a little deeper, filling the drains one third with pebbles and broken stones. When the ground has been nearly level, I have often drained several acres effectually by one drain.

Lime and dung are usually put at once on the summer fallow; but I think the dung is better put on with turnips, and lime with peas, (to which it is always in the highest degree beneficial,) or with wheat. With the latter crop, I think dung should never be put, unless it has been mixed and well incorporated with earth in the preceding summer; for it is apt to remain in lumps, by which some roots are over fed and thrown down, whilst others are starved.

The same pasture can rarely be employed, with equal advantage, in fattening different kinds of stock; bullocks requiring herbage of some length, and sheep preferring that which is close and very short. The best food for bullocks is always, I imagine, afforded by a deep rich loam; but the best feeding ground I have seen for sheep, is of a more dry and sandy, though rich kind.

The herbage of some fields I possess, which are remarkable for fatting sheep, is formed almost entirely of the crested dogs-tail and ray-grass, with a moderate quantity of white clover. Cows do not afford a large quantity of milk, nor of rich quality, though the herbage is very similar (as to the kinds of plants), to that of some excellent pasture I have examined in Cheshire; in which, however, the ray-grass did not so much abound.

I apprehend, that the fattening quality of grass or hay, depends much more on the nature of the soil which furnishes it, than on the species of plant: the herbage of the pastures adjoining, if equally dry, is usually formed of the same species of plants, whatever the different excellence of the soils.

The adjoining meadows or pastures will, I believe, generally point out the best grasses; to the seeds of which white clover at least should certainly be added. From a small quantity of grass seeds I collected last year, I think that a sufficient quantity to sow an acre with any one species of grass, may be collected by women and children for less than 10s.; and a judicious mixture of these, would certainly afford a better herbage than the assemblage of the seeds of weeds collected from hay. Ground is rarely in so good a state to sow with grass seeds, as after it has borne a crop of turnips, which have been properly hoed and grazed off, and the ground ploughed before Christmas.

When ground is at all over-stocked, it is I believe always done with loss to the farmer and to the community. If a young growing animal be kept poor during one part only of the year, it will scarcely ever thrive well during the remainder; and when ill fed, will never attain its proper size and proportion: the quantity of offal will in consequence be greater in proportion to its size. When a pasture is bitten extremely

close, it does not spring again immediately; and hence the greater injury of geese and sheep on young grass in the spring, than of those animals which do not bite so close.

Herefordshire is rather a rearing than a feeding county; and little except hay or straw, and turnips, are given to oxen when in the house.

Many turnips are raised, and some are usually given to ewes and lambs in the spring; but the Archenfield sheep being a small sized animal, and being extremely patient of hunger, subsist on the pastures on which the larger stock have fed during the summer, with the assistance of a little pease halm in the cot at night. The turnips are usually kept for the oxen which are to be sold in the succeeding spring, or are given to the calves and young cattle.

I had a cow-pasture nearly covered with thistles, which had been cut with the scythe twice or three times every year, without appearing to have suffered any diminution; on the contrary, I thought they increased; but by mowing the ground for hay three years, they totally disappeared. Rushes are always in this country produced by surface water, and removed by taking that away, and frequently mowing them. Thistles in tillage are most troublesome weeds, and it appears almost impossible to destroy them; they are much weakened, and in part destroyed, by a crop of turnips properly hoed, succeeded by beans drilled in alternate narrow and wide rows; the former standing on narrow ridges about eighteen inches apart, leaving a space of three or four feet between them, and the next rows for the plough. The hand hoe during the whole summer must be constantly employed to destroy those weeds which escape the plough in the wider intervals, and the horse hoe in the narrow. The whole expence does not exceed a guinea an acre, when the ground is thoroughly worked, and kept clean from weeds, and the produce is nearly as great as when it occupies the whole surface of the ground.

I have never been able to observe that the dispositions to become fat, at all depended on the size of the animal. When at grass, it is impossible to ascertain what each cow consumes in the pasture; but in the house, the same quantity of hay is given to the smallest and to the largest cow, or ox; and it frequently happens that the largest cow keeps itself in the best condition. The quantity of food they consume, is certainly not in proportion to their bulk; and therefore large animals are most profitable to the farmer, or at least to the grazier; and as the quantity of offal *necessarily* becomes *less*, in proportion to the weight of the animal, provided its form be equally perfect, the largest animal is the most profitable to the consumer: because the size of the

bones will of course be in proportion to the weight of the living animal, and the weight of the four quarters, compared with the living weight, will always be least in the least animal.

Breeding in and in, has been little practised in Herefordshire; but all who have tried it, agree that the young stock decreased rapidly in size on the same pasture, but that they discovered no other ill or good effect. I am informed from authority, which I believe I can safely trust, that the late Mr. Prinsep, having maintained the contrary opinion during a great many years, confessed at the end of his life, that his cattle had decreased in size, in spite of all his endeavours to prevent it, by keeping his young stock, well. As the animal decreases in size, it may reasonably be expected that it will decrease in vigour and activity; but how far its becoming more lethargic will make it feed, or live on less, has not been ascertained. A dull heavy eye is, by the dealers in oxen, esteemed an extremely bad point: they, on the contrary, wish to see the eye and countenance brisk and lively; and say, that an ox with a "cloudy eye" rarely fattens well. I have however not the smallest doubt, but, that very beautiful animals will be obtained by breeding in and in, for the following reasons: the young animal comes into the world on a small scale, but by keeping it fat from the first moment of its existence, it is made to attain a greater size than Nature intended, and its weight will in consequence be very great in proportion to the size of its bones. But this is far from proving that the practice is eligible, though it may afford one man an opportunity of selling a few animals at an enormous price. It is well known that those gentlemen who have followed the system of breeding in and in, have spared no expence in feeding their young stock; their breed ought, in consequence, to have attained a larger size; but they are much less, and (if I may judge from the few I have seen from some of the first stocks,) they carry less fat on their best points than the Herefordshire cattle do, which from one year old, are generally maintained during the winter with straw, and are very moderately kept during the summer. Some of Mr. Fowler's breed, of Rollright, have migrated into the borders of Herefordshire, but they are not approved of by the farmers; some of whom attending the sale, declared that they would not have accepted the whole stock, had it been offered them, on condition of retaining the breed. In another animal (the dog), I have had an opportunity of observing the effects of breeding in and in: the breed has become less in size, but not less keen or active; and by crossing again with a breed of no larger size, it has attained its former weight. Some experiments of crossing the breeds of plants, have thoroughly convinced me

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that in the vegetable, as well as animal world, the offspring of a male and female not related, will possess more strength and vigour, than when they are both of one family. I do not, however, think that crossing dissimilar breeds of cattle has ever a good effect: the breeds mix, without assimilating. When the long-horned breed of cattle has been crossed with the Herefordshire, some of the offspring have followed one breed, and some the other, and some presented an awkward mixture of both.

A change of pasture of the same quality produces, to a very great extent, a greater accumulation of fat. Over-fatting stock, is both a disadvantage to the grazier, and an injury to the community.

In regard "to sheep being more valuable as stock for pasture lands, than bullocks, or most profitable to the grazier, and advantageous to the community, by raising more flesh on a given quantity of pasture land in a given time, independent of their growing wool," much will depend on the kind of pasture. If it afford long coarse grass, it will certainly pay much more to the farmer and the community, by rearing cattle: but if the grass it affords be very short and fine, sheep will be the most advantageous stock. Small animals, however, taking the creation throughout, will be generally found to consume more, according to their weight, than large ones; and where the pasture will maintain a large animal, it will, I think, rarely pay the farmer to depasture it with a small one, unless it be of a better breed. A heifer of the best Herefordshire breed, will become extremely fat at 20 months old, and will weigb deducting the offal, 380 lb. I do not believe that three sheep, weighing 20lb. a quarter, ever were, or will be reared on the same weight of food. The wool of the sheep must be put into the scale, but the hide of the cow is of much more value than the skins of the sheep. Cattle will also fatten on land of much worse quality, than sheep: at least than any sheep I have seen, though they will require grass of greater length.

No means of making accidental varieties permanent either in the animal or vegetable world, are (or probably ever will be) known. Attention to breed from the best, appears all that is necessary, or can be done.

The disposition to fatten in the sheep, in the north-west district, is in proportion to the fineness of the wool; but I do not know that it is so amongst the Archenfield breed. A sheep whose wool is close and fine, appears to me to possess many advantages; less is drawn from the body of the animal to support a light fine fleece, than a coarse heavy one of the same value. A long coarse fleece admits the rain readily, and is apt to divide in the middle of the back, admitting the water to the skin; it also imbibes

a large weight of water, which must incommode an animal already loaded with a weight of wool. The fine close fleece of the Archenfield sheep, with much difficulty admits the water, when the animal is placed up to its neck in water to be washed, and it is never wet through by rain. From its close impervious texture, the rain only lodges on its outside, and is almost entirely parted with, by the sheep simply shaking itself; a fine close fleece is much more warm, and at the same time more light; and agreeable to this theory, I am confident no breed of sheep in the Island will subsist on so small a portion of food, as the Archenfield, or Herefordshire Ryeland. Larger sheep, as feeding stock merely, are I believe much more profitable; and I have not the least doubt, but that large sheep with very fine wool, may, and will be produced at no distant period.

Little attention has in general been paid to the improvement of wool, the farmer merely selecting one of the best of his own lambs, as a ram. Some crosses have lately been made with the Spanish, but the produce I have seen are ugly (as they must be, if like the Spanish,) and are, I am informed, subject to the foot-rot. Some crosses have also been made between the Archenfield breed, and Mr. Bakewell's, by which the wool is of course much injured as to fineness, but is, as well as the carcass, increased in weight; and where cattle are not reared, they are, I think, a good kind of sheep. A few of Mr. Bakewell's breed unmixed are in the county; but large fat mutton does not appear to suit our markets, for the butchers complain that they cannot sell it at any price.

In the best stocks, the weight of the oxen is from 25 to 35 stone (12 lb.) and upwards, a quarter: an Archenfield wether sheep from 16 to 18 lb. a quarter, yielding between 3 and 4 lb. of wool, worth 2*s.* per lb.

For the qualities desirable in an Herefordshire ox, I wish to refer to Mr. Marshall's Rural Economy of Gloucestershire, Vol. II. p. 245, and Vol. I. p. 226. I have nothing to add to his description, except that the root of the tail should be broad, to prevent the cavities which appear at the nache in the Lincolnshire breed, and Holderness; and that the root of the tail should contain some fat, when the animal is not in high condition. The coat should not only be "bright and silky," but the hair should be short, and not waved, as in the long-horned breeds. I know no particular marks that constitute a good breed of the Archenfield sheep for feeding, which can in any exclusive degree be said to belong to them. The forms of many of them are very beautiful; they are without horns, and white faced, low and broad, and contain more

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weight in the same compass than any breed I have seen (except the new Leicester). As a stock, where sheep are the principal objects of the farmers' attention, and where his ground is capable of maintaining a large breed, I should not recommend them; but where cattle are, as in this country, the farmer's first object, and where the sheep are compelled to seek subsistence on the fallows and stubbles in the summer, and on the scanty remains of herbage the cattle have left in winter, I believe no breed in the Island will be found so profitable as the Archenfield. Some gentlemen have introduced the new Leicester (Mr. Bakewell's) breed, and they assert that the profits from those are greater; but I have only seen them in pastures where a large ox might have subsisted, and there, though I readily admit they pay more than the Archenfield or any small breed, I cannot admit that they pay for the herbage they consume. The fleece of an Archenfield, and of a new Leicester sheep, (it is admitted by the advocates for the latter breed,) are nearly equal, though the latter is twice the weight. The new Leicester acquire a larger weight in a given time, than the Archenfield, and on a rich pasture they will certainly bring into the market a much greater weight of flesh per acre; but if the sheep is to continue, what I apprended Nature meant it, a mountain animal, and to feed on those pastures which will not support larger stock, nor indeed any other kind of stock, I have no doubt that the new Leicester will be found a less valuable variety than the Herefordshire, whenever the experiment is fairly tried. A pasture which is worth 7*s*. or 8*s*. an acre, is as good as the Archenfield sheep ever requires; and I have not the smallest doubt that three acres of land of this kind, will bring into the market a much greater value of wool, (with as much mutton) than an acre worth 30*s*. will do with the new Leicester, and on land of this value alone, I have as yet seen them kept in any county.

Neither the Herefordshire breed of cattle or sheep are liable, in any exclusive degree, to any particular disorder, that I know of.

Every small animal consumes more according to its weight, than a large one. The mouse will probably consume its weight ten times, in the same number of days that an ox would require to consume his weight once; and an ox would probably do it, in proportionably less time than an elephant. I have not been able to discover that a small Welch ox required much less hay, than a large Herefordshire one, during a winter; and I therefore conclude, that the largest animal the pasture can support, will always pay the farmer and the community best; particularly in those kinds to which preserved food is carried in the winter. There are, however, many districts in

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which the want of water, of natural pasture, and of inclosures, must render sheep a more eligible stock than oxen; but where the ground is equally capable of affording food to cattle and sheep, I am confident that the least animal should be the second object of the farmer's attention, and that each species should be as large as the length of herbage will support. Two years ago, I had some yearling heifers which were perfectly fat on ground not worth more than 5*s.* an acre, and on which I never have seen a sheep half fed, the grass being of very bad quality.

Another Letter from the same Gentleman,

ON THE SIZE OF ANIMALS.

Dear Sir,

I should sooner have sent you my objections to the statement contained in Mr. Culley's letter, which I received from you, but I wished, before I wrote, to know whether the experience and observations of some very eminent breeders in this county agreed with my own. As I expected, I found that they had drawn conclusions in direct opposition to most of Mr. Culley's. Looking at their oxen of different sizes, but of the same age, I asked, what was the difference in the weight of food consumed by the largest and the least, in twenty-four hours? I put this question to several different breeders, in different places, and they all unanimously agreed, that the same quantity of food was given to the smallest and the largest beast of the same age, and that the largest, even when not master of the same fold, often kept itself in the best condition; and that every thing depended on the disposition to fatten, and very little on the size of the animal. In my own stock, I can assert that this is precisely the case, and I think almost every breeder in the county of Hereford will declare that it is so, in his. Mr. Culley's observation, therefore, that cattle generally consume in proportion to their weight, is not applicable to the cattle of this county; nor, I suspect, to that of any other: at the same time I admit, that a hundred large cattle will generally consume more than a hundred small ones; but by no means in proportion to their weight.

Mr. Culley's second statement is, that small animals are generally worth more per stone, than large ones, when fat. I apprehend directly the reverse of this to be true, taking the animal as it stands in the stall, or pasture; but if the butcher buys the profitable parts (as they are called) only, receiving the offal into his bargain, he will most

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certainly give more for two cows of twelve stone each a quarter, than for one of twenty four, and the reason is extremely obvious. The offal is of more value, and the hides alone, if equally thick, (and the strength of the hide does not at all depend on the size of the animal) will be nearly as 17 to 12. The difference between the weight of animals, when living, and of the four quarters, when dead, is always in an *inverse* proportion to their size, when their forms and merits are equal; but the bones will *then* be in proportion to the *living weight*, and therefore small animals must be in this case *most disadvantageous to the consumer*. Any man who possesses the least sensation in his fingers, will readily perceive, by handling the cows or oxen of the Holderness, or Lincolnshire breeds, that their hard brawny flesh must be of inferior value to that of many smaller breeds; but I believe Mr. Culley can not point out any breed at present, of any size, whose flesh will sell at a higher, if as high a price, in Smithfield, as that of the large Herefordshire blood ox. When meat is cured for future use, there is always less waste in that of large, than of small animals, as it necessarily presents a less external surface: this is in a particular manner applicable to hogs.

A third statement is, that small animals are generally of a hardier nature. If Mr. Culley means merely that they will subsist on shorter herbage, he is certainly right. A large animal, though precisely in the same form as a small one, necessarily requires more hours of rest. It does not stoop for a mouthful of grass, nor remove itself from one place to another in search of it, without greater labour; for, supposing an ox which weighs thirty-six stone a quarter, to be as strong again as one of eighteen, it will still be (relative to itself) a much weaker animal. Its head and neck will be just as heavy again, and by their greater length, the weight will recede farther from the centre of motion in the shoulders; and in consequence, will increase in power, in proportion to the distance, like that on the beam of the steelyard. The same remark may be applied to every limb of the large animal. But in the stall or fold, where oxen are usually fed, these disadvantages vanish entirely, because they here receive their food without the labour of searching for it; and if the necessity of a better pasture, does not arise from the larger animal's consuming considerably more, but from its inferior power of collecting food, it follows, that it will afford the largest weight of flesh, with the smallest consumption of grass.

Mr. Culley's fourth and last position, stands on better grounds than either of the preceding; but I doubt whether this, in its whole extent, be strictly tenable. The foot of an ox of thirty-six stone a quarter, is necessarily less wide in proportion to the weight

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of the animal, than, that one of eighteen, equally well made; for the weight increases in cubes, and the width of the foot in squares only: but the question is, whether the feet and mouths of the two small animals, will not injure the herbage more than that of one large one? Small sheep do not poach the ground at all; yet I think a score of these, weighing a ton in the aggregate, will do more injury to a rich pasture in forty-eight hours, than one ox of the same weight will in a week. Cows and oxen are, or ought to be, kept in the stall and fold, when the ground is wet during the winter, and liable to injury from treading; and in the summer, when moderately dry, it receives no injury from the weight of the heaviest animal. I have heard that one of the great excellencies of the improved breed of Mr. Bakewell, was that of having the unprofitable parts, such as the bone below the knee, and the foot, extremely small. If his cattle possess this excellence in any very extraordinary degree, their weight, according to the width of their feet, will be as great as in the larger breeds; and they will consequently poach the ground just as deep. For dairy stock, where the weight of flesh is a secondary consideration, I will agree with Mr. Culley in the advantages of small cows; they give nearly as much milk, individually, as large ones, and will collect their subsistence from shorter herbage, and with less injury to the ground; but where the weight and value of the flesh is the object of the breeder's pursuit, I am thoroughly confident that the largest animal, his pasture is calculated to support, will be found most advantageous to the breeder and to the community.

I am, &c.

THOMAS ANDREW KNIGHT.

Elton,
March 31st, 1798.

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VIII.

Experiments on Fatting Sheep.

Bowlney, 5th April.

THE latter end of April, 1796, I bought 12 sheep at £3. 3s. each; the beginning of June, bought 20 at £3. each; these were sold the March following: the latter end of July, bought 10 more at £2. 14s. 6d. each; these were sold the Christmas following: the 42 sheep when sold, averaged at £7. 14s. each. In April, 1797, bought 24 at £3. 10s. each, which were sold the next Christmas at £7. 12s. each. This last year I had 27 at £3. each, part of which was sold at Christmas, the others last week; the whole of those averaged at £6. 18s. each; and what is rather extraordinary, I never lost one, nor sold one for less than £5. I assure you they have paid me wonderfully well.

The sort of sheep I had the first year, was 22 poled Gloucestershire, and 20 horned Wiltshire; the age of the former was 6-tooths, which is four years old; the horned sheep was one year younger: they had nothing but grass till the middle of October; they were then fed with oil-cake and beans mixed together; I cannot say exactly what quantity, but I remember it came to about one shilling per head a week, besides hay and turnips: the weight of the sheep I do not know, as the greater part of them were killed in London and its neighbourhood. The 10 sheep that were sold at Christmas, were not so large as the others, neither were they so long feeding: my salesman was informed, that those weighed about 19 stone a sheep, 8 lb. to the stone; the others not less than 24 stone the average, as I was in town at that time, and saw the weight of several of them: the next year sheep were all of the Gloucestershire breed, fed in the same way as the others, but were only ten weeks on corn and oil-cake; and I can take upon me to say, that the corn and cake did not cost me more than 10s. per head; and from the best information I could get as to the weight, should suppose they averaged at about 24 stone; were all 6-tooth sheep. The last years were of the same breed, and the same age, except one, which was a Berkshire sheep, and only a 4-tooth, which weighed 23 stone 7 lb. which is the greatest weight I ever heard of, for that sort of sheep: these were fed in the same way as the others, and were not more than ten weeks on corn and oil-cake; and as to weight, rather exceeded any I had before, but was not so fortunate to go to so good markets; but of the three sorts of sheep which I have had, I much prefer the Gloucester.

E. GREEN.

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IX.

Copy of a Letter from Mr. CAMPBELL, *at Fort* Marlborough, *with an Account of various Seeds sent by him, by the* Queen *Indiaman.*

SIR,

SINCE I had the honour to address you last, I have in my travels and inquiries on this coast, kept in view my purpose of communicating any information in my power to the Board of Agriculture.

Yet, whilst I have met with much matter of philosophic speculation, I cannot boast of any acquisition which can add to the sum of practical knowledge, or tend to the advancement of the arts of life. The rude, and almost instinctive essays of an infant people, cannot be expected to yield information to the economicks of polished nations.

My effort thus limited, I direct my attention to the design I formerly projected,—that of transferring the useful trees and plants of this island, to our West Indian colonies, and the continent of America. Aided by your influence, I cannot permit myself to doubt of its ultimate accomplishment.

The advantages to be derived from such an undertaking, may be conjectured and anticipated; and, in the certainty of your giving energy to my endeavours, I have lately engaged myself in curing such seeds as I think, from my local knowledge, most interesting. If this operation can be well effected, it will secure, at least a probability of their vegetating in every latitude betwixt the tropics.

But failure will not baffle me :—should the first efforts be successless, every conveyance will present to your Board, parcels of such as the season may afford, with frequent duplicates. In the distribution of them, your ample sources of information will determine; and I am convinced they will not be confined to our colonies alone, but diffused with an equal hand throughout the world.

Those which go by the Queen are, the cordage palm; the caminium; the copaya, or oil-nut of the Malays; the teak; the soy bean, of Japan; and the catupa, a delicate fruit lately discovered. At intervals, I hope to supply the desiderata of Bryan Edwards's catalogue of the Hortus Eastensis; *Hist. Jamai.*

The adjoined catalogue contains short notices and references to works in which these plants are amply treated of.

With my most respectful regards for the President and Society,

I remain, &c.

Fort Marlborough,
17th. May, 1798.

CHARLES CAMPBELL.

Account of Seeds sent in the Queen *Indiaman.*

Saguerus ebrius: wine, sago, and cordage palm.

This very useful tree has not been accurately described by any modern botanist; it bears considerable affinity to the *Cleophora* of Gærtner; but I wave botanical minutiæ, as superfluous in this place. It is the *Anou* of Mr. Marsden's excellent volume; the *Palma indica vineria secunda Saguerus sive Gomutus dictus*, of Rumphius *Herb. Amboin.* Vol. I. p. 57. Tab. XIII.

Its domestic uses are so very various, that I cannot too strenuously recommend its culture. The wine which exudes from its racemus, affords a good sugar:* the filaments which envelope the trunk are twisted into cable, far surpassing those of coyar; and indeeed seem the most incorruptible vegetable material in nature: the cloth-like substance found about the origin of the footstalks of the leaves, is used in caulking, and tolerably supplies the place of oakum. In times of scarcity the pith yields, by very simple management, a sago, less in quantity indeed, and not so delicate as that of the *sagus farinifera*, but not despicable. To dwell upon its many properties were tedious; I therefore refer to Rumphius *de Usu Sagueri Arboris*, where, amid much imbecile prolixity, every necessary information will be found.

I can confirm his observations, that it affects shady humid valleys, where the soil is very moist, and mingled with stony concretions.

Copaya Oleosa Pangium; *Herb. Amboin.* Vol. II. p. 189. Tab. LIX.

This tree is of the class *Diœcia*, and, as far as I know, has not as yet been assigned its place in the system: Rumphius never saw its flowers. It stands in my catalogue among the new genera. I may be mistaken.

It is also a tree of much domestic utility. The oil which the kernel of the nuts yield, is delicate; for the process of obtaining it I again refer to Rumphius, † remarking

* And by distillation, a spirit similar to arrack.

† The oil is extracted either by pressure, or by infusing the kernels in warm water, and skimming it off from the surface.

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only, that the farina of the kernel, containing before preparation a noxious matter, is a dubious food, and little used as such by the Malays themselves. It is hardy, and no choice in its soil.

Camirium Cordifolium, Gærtner, Cent. Tab. CXXV. fig. 2.

Camirium, Rumph. Amboin. Vol. II. Tab. LVIII.

Carneeling, or *Boa Cray*, Marsden's Hist. of Sumatra.

This nut, and the expressed oil obtained from it by pressure, is in much culinary use among the Malays; the latter, some time ago, was fashionable as a salad oil in Calcutta, to which side of India it is, I believe, exotic.

This tree is hardy, and sustains the cold of the hilly parts of this country, where the cocoa nut will not live, or if it exists, becomes abortive.

In the central district of Corinthia, situated beyond the vast Alps which divide this island in a north-west and south-east direction, I found it the only resource of the aboriginal inhabitants, both as a grateful addition to their simple fare, and a substitute for oil in lighting their houses. The kernels were beat into a paste, spread over a bit of rag, and that again wrapped round a whisp of split bamboo, so as to form a very simple candle.*

The thermometer in these regions stood at 63 degrees, Fahrenheit's scale, in the morning; a difference of 17 degrees from the medium temperature of the plains.

Its soil is a yellow clay, covered with a slight coat of black mould.

Tectona grandis, the Teak.

This valuable timber† is not indigenous to Sumatra, although frequent in Java; I am, however, endeavouring to naturalize it. Dr. Roxburgh, of Calcutta, has been uncommonly successful in introducing it from the Coromandel coast to Bengal. The seeds I now transmit, are part of a parcel received from him a few weeks ago.

Their culture is simple; in tropic climates, they should be sown about the commencement of the periodical rains; any land will answer, that is not subject to be

* This tree is the *Aleurites* of Forster. The nuts are used in the South-Sea islands for candles; the kernels being fixed upon a skewer, which pierces them through; the upper one is lighted; this burns with a clear flame for some minutes, and sets fire to the second, before it is consumed; when the second is well lighted, the candle is snuffed by breaking off the first, if it has not before dropped down, by the fire having burned through the substance of the skewer that supports it.

† As ship timber, the Teak is far superior to the oak for easy workmanship, and is much more durable. A Teak ship will run three, four, or five times as long as an oak one, without material repair.

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inundated. At about four inches high, they should be planted out in the place where they are to remain till they attain their utmost growth. In Bengal they have thriven so well as to measure from three to four feet in circumference, at the age of ten years. I perceive that there is a specimen of it in the *Hortus Eastensis*, in the Liguanea mountains. Bryan Edwards's Hist.

Dolichos Soja, the Soy Bean.

This pulse is exotic to the West coast, and seemsto have been imported by the Chinese colonists.

It is little cultivated here; and never, I believe, with a view to prepare the condiment from it.

Much of the sauce sold in Europe, under the name of Japan Soy, is manufactured at Batavia, by a very simple process. Satisfactory information will, I believe, be found respecting this, in Kempfer's *Amœnitates*, a work I regret the want of.

Catapa racemosa.

Of this tree I can give little account; it is yet but obscurely known to me, and I am willing to reckon it among my embrio discoveries.

The fruit is *tricoccus*; grows in a raceme; the seeds covered with a flesh-coloured pulp of great delicacy, combining the raciness of the grape with the flavour of the peach stone.

I had hopes of being able, by this conveyance, to supply the seed of Upland, or Ladding rice, to our West Indian colonies, where I understand it is still a desideratum; the backwardness of this harvest has disappointed me.

I close this, congratulating my country on the probable result of your associated labours for the welfare of mankind: in their beneficent consequences, they will be remembered, when empires shall have passed away, and Time, in his annihilating progress, will only give to them stability.

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X.

Account of Experiments in cultivating Rice, brought by Sir John Murray, *from* India. *By the Right Hon. Sir* Joseph Banks, *Bart. K. B. and P. R. S.*

My Lord,

As I conceive the introduction of new esculent vegetables, a matter of material importance to the agricultural interest of this country, and that even an unsuccessful experiment on this subject may be, though not perhaps fitting for publication, a proper document to be lodged in the archives of the Board of Agriculture, I take the liberty of submitting the following remarks to your Lordship's better judgment.

The dry, or mountain rice, which I received last year from the Board of Agriculture for trial, had been procured at some considerable expence by Sir John Murray, from the neighbourhood of Serinagur, a city in India, situated at the foot of Mount Imaus, where snow lies till late in the spring; and where the climate has been supposed to resemble that of England, sufficiently to make it probable, that the vegetable productions of the one, would equally succeed in the other country; I consider it as a duty owing to the patriotic exertions of Sir John, to give your Lordship and the Board, some account of the result of the trial of it, made by me at Spring Grove, near Hounslow, in Middlesex.

It was not till near the end of May, when the samples, being of six sorts, were delivered out by the Board, and they were sown immediately, on the 21st day of that month, on six small beds in a garden, under the shelter of a pale, in a south exposure.

The grains were sown very thin, in order that the progress of their vegetation might be the better noted; in a very few days they appeared above ground. The season being warm, with a moderate supply of rain, it was seldom necessary to water them; however, when they appeared to flag, which generally happened after three or four dry days had taken place, they were well sprinkled with a watering pot.

In less than a month they had grown several inches high; each sort had acquired an appearance very different from the rest; some were pale green, and had broader blades; some were deeper coloured, and narrower in the blade; and one sort had a brown hue on the whole plant; and the bases of the leaves, in this kind, were nearly black.

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During the month of August, they tillowed much more than I have observed any other corn to do; so much so, that although they had been sown very thin, they became a dense compact bed of plants; the blades in some of the kinds standing as close or closer to each other, than the thickest sown barley ever does.

At the close of the month, the blades were from a foot to eighteen inches high; the plants continued to tillow, each root having by this time produced from ten to twenty offsets, but no symptom of a rising stem was at all observable.

In the middle of September, they had still continued to tillow, and the blades to lengthen, so that some of them were at least two feet long. As the frosts of the autumn were now nearly approaching, it became an object of some importance to examine the state in which the plants really were, in order to ascertain the probability of their having produced ears, or possibly of their having ripened corn, if they had been sown a month or two earlier. The most careful inspection was therefore made by dissection, but no traces could be found of the rudiment of a joint beginning to form itself on the crown of the root, or of the embrio of the glumes of the ear, which in all kinds of corn are first discernible in that part.

About this period I was taken ill, and obliged to desist from observing their future progress; but a frost soon after followed, which cut the blade down to the earth, and at once destroyed all hopes of these kinds of rice producing grain in our climate: the quantity of the blade was however so uncommonly great, that it is not impossible it might be advantageous to sow it as food for cattle, for a very large proportion of stock might certainly be maintained upon an acre of it.

Before the frost set in, I had ordered a tuft of each kind of the rice to be transplanted into a pot, and placed in a hot-house, in order, if possible, to ascertain the natural period of this grain; whether, like winter corn, it requires eight or nine months to come to perfection, or, like our Lent corn, arrives at the same period in five or six; but all of these died, notwithstanding great attention was paid to them: some seed however, which I had given to Mr. Lambert, succeeded better; it was sown in his hot-house in the month of June, where it throve well, but did not produce ears till near Christmas, a period of seven months; from whence, as it is not probable the grain would have ripened in less than two months from the time when the ear appeared, it is easy to deduce, that in the neighbourhood of Serinagur, these kinds of rice are either sown as winter corn, or the climate there, is far better suited to promote the quick progress of vegetation, than ours is. It was, when it produced ears, about

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three feet and a half high, and some of the stems had five joints, including the radical one: had it been in a more suitable climate, it would certainly have grown taller, for the flowers dropped off without producing seed.

In the course of this spring I have forwarded a few seeds, which were left from Sir John Murray's importation, to Portugal; if they succeed, I shall probably hear of it; and in that case, if your Lordship feels interested on the subject, I shall certainly do myself the honour of communicating such information concerning them, as I am able to obtain.

I have the honour to be, &c.

JOS. BANKS.

Soho Square,
April 15, 1799.

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XI.

An Inquiry into the Cause of the Blight in Wheat, which occasioned the Failure of the Crop in the Summer of 1795; with Observations, and a Mode of preventing a Repetition of the same evil. Also, an Account of the Origin and Increase of Smut Balls, Vermin, &c. By ROBERT SOMERVILLE, *Esq. Surgeon 1st Battalion 8th Fencible Regiment.*

THE failure of the wheat crop last year, and the scarcity and high price of that article occasioned thereby, the distressing effects of which still continue to be felt, have not only created a just and well founded alarm, but also given rise to a serious inquiry into the cause.

In a conversation with the President of the Honourable Board of Agriculture, about the end of July, 1795, when the evil first began to assume a formidable appearance in England, he shewed me some blighted ears that had been sent him by a gentleman in Yorkshire; at the same time requesting me to examine the wheat in my neighbourhood, and make observations upon the subject.

Owing to the crop in East Lothian being considerably later than in Yorkshire, the wheat exhibited no appearance of disease at the period above mentioned; nor had it, to a superficial observer, sustained any apparent injury, but what seemed to have arisen from a scarcity of plants occasioned by the severity of the preceding winter.

The crop had at that time just shaken the flowers, and the grains were beginning to form, most of them seemingly healthy; upon a close inspection, however, I discovered that many of the blades and stalks were rather of a dirty green colour; and in about a couple of weeks afterwards, I could distinctly perceive a great number of small red insects. This appearance alarmed me not a little; as I imagined that, at a more advanced period of the season when these insects became stronger, and were more numerous, they would be equally destructive to the crop in this country, as they had been in England. This I communicated to the President of the Board, at a time when, I verily believe, no person on this side the Tweed seemed to entertain the least apprehension of danger. The consequences are sufficiently known; and it is with no small degree of pain that I say, the prediction was fully verified. As the season advanced,

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the insects not only increased in size, but became also more numerous; and in almost every field, the grain began to manifest strong and unequivocal symptoms of disease: these were so formidable, that in many instances a total loss was dreaded, and in not a few cases, one half of the crop was actually destroyed.

In the course of my inquiry and observations upon this subject, I entered into, and carefully examined every field within my reach; and having commenced them at an early period of the season, I had an opportunity of tracing the evil almost from its origin, to its termination at the ripening of the crop. In that way, I became possessed of many facts and circumstances not generally known; the publication of which may, perhaps, be attended with some benefit to society. To give a detailed account of these, as well as an accurate description of the different varieties of the disease in its several stages, will be the business of the following sheets: and I flatter myself, that any thing which may be the means of throwing light upon an evil of such magnitude, or that may have the most distant tendency to prevent a similar misfortune in future, will not only be highly acceptable to the Honourable Board, whom I have now the honour of addressing, but also to the public at large.

Having premised these observations, which I trust will not be thought superfluous, I now proceed to mention the different appearances that occurred in my observations. In describing these, I will be under the necessity of using different terms for every variety of the disease: these terms I will accommodate as much as circumstances will allow, to the commonly received ideas upon similar subjects.

1. *Symptoms of the Blight.*—In the very early stages of the disease, and before the ear was affected, the green blades and stalks were spotted with black and rusty spots.

2. After the crop had begun to shoot, and was fairly in the ear, many of the heads were entirely empty.

3. A great number of the ears were entirely empty in the upper part, while the undermost half was very well filled.

4. In very many cases, the ears had a plump well-filled pickle, and an empty husk alternately.

5. Many of the ears, though not entirely empty, contained only small shrivelled grains, or what are called hungry pickles.

6. A number of ears were partly hungry, and partly well filled.

7. A great proportion had a hungry and a well-filled grain alternately.

8. Many ears though well filled were, upon opening the husks, found almost entirely covered with black and rusty spots.

9. A very great number of the stalks were entirely withered from top to bottom.

10. One whole crop when ripened, in place of being of a clean, healthy, yellow colour, had a dirty, spotted appearance, as if it had been sprinkled with soot; and even these parts of the straw, or ears, that had no black spots upon them, were not white, nor yellow, as is commonly the case, but of a dusky, or ash colour.

The above are the most striking phænomena that presented themselves to my observations; and having mentioned them in a general way, I will now take notice of each separately, and afterwards attempt an explanation.

1. *Of the Spotting upon the Green Blade and Stalk.*—In the preliminary observations I have mentioned, that, previous to the appearance of any real injury, and indeed before the ear had shaken the flowers, the blades and stalks, in place of being of a healthy green colour, had a dirty appearance, and were in a great measure covered with a mixture of *black*, *brown*, and *white* spots.

The black and brown spots seemed to be occasioned by a glutinous substance deposited upon them, easily soluble in water, and which could be readily washed off, by rubbing the parts with a wet cloth. The white on the contrary, seemed to be owing to wounds or punctures made by vermin; and which, in consequence of the destruction thereby occasioned, withered, and became white.

As the season advanced, the black and rusty-coloured spots became much larger and more numerous; and when the grain began to ripen, not only the blades, but the straw, were almost entirely covered with black spots.

2. *Of Decayed, or Deaf Ears.*—In every instance that I met with, where the stalk was green, and to appearance tolerably healthy, and the ear at the same time withered, and without grain, the misfortune seemed to have arisen from an injury done to the neck of the ear, immediately at the place of its junction with the stalk. In that place, the outer rind was destroyed all round; by which means the circulation between the ear and the stalk was cut off, and hence the decay of the head; in this case, the evil seemed to be exactly similar to what takes place in trees and herbaceous plants, that have had the bark destroyed by any accident; as in every instance where that takes place, if the injury extends to the whole circumference of the tree or plant, all the superior part of it dies.

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3. *Of Ears, where only the upper half was blighted or Empty.*—In all the instances that I met with, where only one half of the head was empty, and the other half tolerably well filled, the empty part was uppermost; and the injury was owing to the rind being destroyed about the middle of the ear, at that place which separated the full from the empty part, and was exactly similar to the injury done in the preceding case, where the whole ear was destroyed.

4. *Of mixed Ears.*—By mixed ears, I mean to describe such as consisted of empty husks, and well-filled grains, alternately. The injury in this case, seemed evidently to be owing to a wound inflicted at the bottom of the empty grains, where they are joined to the stalk, and which had taken place while they were in flower; after which they made no farther progress.

5. *Of hungry, or ill-filled Ears.*—The hungry, or ill-filled ears, consisted of such as seemed to have escaped any accident, till they had made considerable progress in filling; after which they became stationary, ripened prematurely, and, in place of having a round, plump, smooth, appearance, were *long* and *shrivelled*, and in the country phrase, *hungry*. Upon examining these carefully, they were found to be injured at the place where they were joined to the stalk, in the same manner as has been already taken notice of, in speaking of deaf or empty ears: and, like this also, the whole ear was in some cases ill filled, in others only half of it was in that state, and in a very great number, the ears consisted of a well, and an ill-filled grain alternately; and, without a single exception, the whole of the hungry grains were wounded at the place of their insertion into the ear.

6. *Of spotting upon the Grains.*—In every field when the blight was common, the greatest part of the healthy and well filled ears had the grains and inside of the chaff covered with numerous black and rusty spots, bearing a very near resemblance to these already described upon the green blades; and like them also, they were easily rubbed or washed off. Upon viewing these grains carefully with a good glass, the downy part of the pickle in many of them, contained several small white transparent globules, resembling the eggs of insects.

7. *Of withered Stalks.*—In many of the fields I examined, especially such as had been fallowed and well manured to the wheat crop, a great number of the plants, in place of being injured in any of the ways above described, were entirely withered from top to bottom; the decay, in most of these cases, took place at the time when the wheat was beginning to shoot. No spotting nor other appearance of injury from

vermin was visible, either upon the blade or stalk; but upon pulling up the plant and examining the roots carefully, a worm, or worms, were found at every one of them.

8. *Of the spotting upon the Ears and Straw, after the Grain was Ripe.*—I have already observed, that the first approach of the disease, was marked by the dirty green appearance of the blades and stalks, together with a mixture of black, or rusty spots. These, as the season advanced, became not only larger and more numerous, but when the crop began to whiten, appeared much more conspicuous; for the straw and ears, in place of putting on a white or yellow appearance, as is usually the case, looked as if they had been sprinkled with soot.

Observations.—Having described the appearances that occurred in the various stages of this disorder, I presume the whole may be accounted for in a very simple manner. The existence of an insect is well known, and every phænomena attending the blight, may be accounted for upon that principle. It has been stated above, that upon the first appearance of the insect, the only injury, which the crop seemed to have sustained, was a spotting upon the blades and stalks; a part of which was owing to a glutinous matter deposited upon them, which was readily dissolved by moisture, and could be rubbed off with very little trouble: it was likewise noticed, that many white spots were visible: these last were evidently owing to punctures made in the tender parts of the blade and stalk, by the insect; and which, in consequence of the injury done to the tender vessels, withered, and turned immediately white; the black and brown spots were nothing more than the excrement of the same vermin, which they had dropt while feeding, in the same manner as flies are observed to do upon glass. Of this I convinced myself in the clearest and most satisfactory manner, by taking about a dozen of the vermin, and placing them upon a healthy plant, at a considerable distance from any that were in a diseased state. They immediately adhered to it, and upon the second day after they were put on, the blades began to be covered with spots, and exhibited in succession all the appearances I have mentioned; when a good glass was applied they could be distinctly seen feeding, and also dropping their excrement upon the leaves.

In the course of this inquiry, I observed, that the insects were fondest of the tenderest and sweet parts of the plant; and in proportion as the stalk was elongated, they gradually continued their progress upwards, always preying upon the new tender growth, and leaving those parts that had become hard, or which had acquired a ranker, or more disagreeable taste. In that way, many of them fastened upon the ear immediately at

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the place where it is united to the stalk; and by the wounds and punctures they inflicted, entirely cut off the circulation between them. Where this injury was done while the wheat was in flower, the whole ear immediately decayed, and was entirely empty. In many instances, however, it so happened, that as the vermin made their way upwards, in place of wounding or fastening upon the neck of the ear, they went higher up; sometimes fastening upon the middle of it, and sometimes wandering from one part to another amongst the grains: where they fastened upon the middle, the upper half only was blighted, and where they ranged over the whole ear, it consisted of a mixture of blighted and full grains, the blighted grains being without one exception wounded at the bottom, or place where they were joined to the ear.

In the case of the hungry or ill filled ears, the same variety was not met with; some were entirely hungry, in others only the upper part of the ear was in that state, and in a great number, there was nearly an equal proportion of well and ill-filled grains, and these placed alternately upon the ear.

Upon examining these, the appearance was no way different from what has been above stated, where they were entirely empty: where the whole ear was ill-filled, the stalk was wounded immediately at the place of its junction with the ear; where only half of it was ill-filled, the injury was done immediately above the well-filled part, and below the hungry grains; and where the ear was mixed, and consisted of a well and an ill grain alternately, the ill-filled grains were wounded at the place of their junction with the ear.

From the similarity in appearance between the injury done to the empty and ill-filled ears, no doubt could remain as to the cause being the same in both. The only difference seemed to arise from the vermin attacking the former, while it was in flower, by which it was rendered entirely empty; and the latter, after it had made considerable progress in filling. The variety amongst the hungry ears was very great; some of them containing scarce any thing but shrivelled skins, while others were tolerably well filled; and it evidently appeared, that their quality was exactly proportioned to the progress they had made in filling, before they were attacked by the insect. In giving an account of the symptoms of the blight, I have noticed, that in every field where it prevailed to any considerable extent, even the plumpest and best filled ears, when the husk was opened, were found covered with black and brown spots, similar to those we have described upon the blades and stalks: these ears, when viewed with a good glass, were found to have a considerable number of small transparent globules adhering to the downy part of the grain.

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The spotting consisted entirely of the excrement of the inse ct many of which were discoverable even upon the healthiest and best filled ears; though they had come upon them at so late a period of the season as not to prevent them from filling, or indeed to do them any visible injury. But though they had thus escaped for a season, the seeds of the disease were effectually planted in them, as the whole of the small transparent globules discovered, in the downy part of the grain, consisted of the eggs of the insect: of this I had very ample confirmation; for, upon confining a number of the largest kind of the insects in a box, along with some clean grains of healthy wheat, they appeared very much spotted the following day: and in a couple of days more, when the glass was applied, several of the grains were found to have eggs, or transparent globules, adhering to the down. When the insect first appeared, I considered it as an accidental circumstance, owing to the nature of the season; and imagined there would be little chance of a similar misfortune the following year, unless the season happened to be equally bad. The circumstance of the eggs adhering to the downy part of the grain, gave me a very different opinion, as I considered, and not without reason, that if the wheat, which contained these eggs, was sown without any preparation that could have a tendency to destroy them, they would either produce an immense number of the same insects the following summer, or by injuring the tender plants, occasion a great deal of smut. This I communicated to the public, through the channel of the newspapers, in two letters addresed to the President of the Board; wherein I gave a short description of the injury done by the vermin, and suggested what appeared to me to be the proper remedy. These letters will be given in the conclusion of this paper; my sole motive for publishing them at that time, being to put the farmers upon their guard, and prevent them from sowing tainted seed.

I have already noticed the dirty appearance of the ears and straw, when the grain began to ripen; this, like the former, was chiefly owing to the excrement of the insects, and helped to mislead many farmers, who, from the colour, were led to believe that their crop had suffered by smut; whereas, in very many instances, scarce a single smut-ball was to be met with in the field. In many of these cases, the evil did not attract general notice till the time of ripening; for this obvious reason, that while the stalks and blades continued green, the spots were not so easily distinguished as when they began to whiten, when the mischief stood *confest.*

In speaking of such plants as were entirely withered, I have said, that in a majority of all that I examined, the injury which occasioned their death had happened about the time they began to shoot, and was evidently owing to a worm, attacking and

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destroying the root within half an inch, or less, of the surface. The number of these withered plants was very considerable; and what seems highly deserving of notice, they were most numerous in lands where the soil was a deep loam, and had been well fallowed and richly manured to the wheat crop; and almost without a single exception the injury was done to such grain only as had either been imperfectly covered, or were very near the surface; while on the contrary, such grains as were placed deeper, escaped the worm entirely.

An attention to this circumstance, if judiciously directed, will probably lead to consequences highly beneficial; not only to the husbandman, but also to the public at large; for if it is uniformly found, that only such grains asare left upon, or near the surface, are liable to be hurt by this worm, while, on the contrary, such as are placed at a greater depth entirely escape the injury; it will then become a question, whether the broad-cast sowing of wheat should be continued in the present way, or if drilling, or dibbling, should be introduced in its stead.

Drilling, from the ease with which it is performed, the regularity as to the quantity of seed, and the equal and due depth at which it is deposited, not only secures the crop from the bad effects of drought, but at the same time places it beyond the reach of fowls, and such insects as would attack the root, if they were nearer the surface.

I have noticed this circumstance more particularly, on account of an observation which I have just now made upon the young crop of wheat. Since the time of sowing in autumn last, till now, I have been at great pains to observe the appearance of the crop, and carefully examined every plant that seemed to be in a sickly or decayed state: upon one sort of wheat lands, I found this description of plants very numerous; the lands I mean, were those where the wheat had been sown after pease, or a mixture of peas or beans. The injury done in this case is not, however, owing to a worm, but to a small slug, or snail: like the former, however, the attack is made only upon the grains that are left upon, or near the surface; while such as are deeper, and better covered, have in a great measure escaped. The evil, as above mentioned, seems to be most extensive upon deep, soft, warm loams, that have been under a pease crop last year: upon fallows, however, that have been well wrought and richly manured, though few of the plants are either sickly or in a decayed state, and no slugs have appeared; yet the worm above mentioned, which occasioned the death of so many plants last year, has bred in the manure in considerable numbers; and though they are yet small,

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and have produced no visible bad effects, there is every reason to apprehend that, as the spring advances, they will be productive of much mischief.

For many years I have been struck with the failure of the wheat crop in the spring, more particularly at the circumstance of this failure happening oftenest upon the richest and best prepared lands, and after the most severe weather was over; and could never account for it upon any other principal than the looseness of the soil, occasioned by the manure put into it, and the operation of the winter frosts.

The observations which I have recently made, have however given me very different ideas; and though I am still of opinion that a number of the plants may, and in fact do perish, by being thrown out of the ground, I am at the same time convinced, that a very great majority of all the plants which die in the spring, are killed by vermin. Their greatest havock is generally upon loose warm soils, which, from experience, are known to be more favourable to their propagation, than such as are colder, and have more tenacity.

The worms here meant bear an exact resemblance to those which destroy potatoes, and are certainly the same. In an inquiry into the cause of that distemper, (the curle,) the particulars of which arenow before the Board, together with engravings of the insects, &c. I have said, that the worms are generated in the manure made use of for the crop. I have there observed, that the knowledge of that circumstance should lead either to a different way of applying the manure, or a mode of preparing it previous to its application, that may prove fatal to the vermin, by killing them in embryo. For the ordinary run of potato crops, I am of opinion that the use of manure my be dispensed with; as experience has fully proved, that they can be raised in great abundance upon moors and mosses, without any manure; and when they are planted upon good lands that require fallowing, the people in the neighbourhood of great towns, and even in villages, very often give five pounds an acre for the privilege of planting potatoes upon this land, which has become dirty, and incapable of carrying corn crops. The producè in these cases being not only great, but also clean and healthy, provided the seed has been good.

Upon wheat crops, however, the same thing cannot be practised, as, unless it be upon lands where dung has been employed for thepreceding crop, such as turnips, &c. there is little chance of raising good wheat, without the application of manure. Now, as I have stated, and I believe upon inquiry the assertion will be found true,

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that great numbers of vermin are generated in the manure, there must always be an evident risk of the crop being destroyed thereby. The only probable remedy for such an evil seems to be, that of either preparing the manure in a particular manner, by mixing it with some substance, or substances, whose deleterious effects will prove fatal to the insects; or by applying it in a form somewhat different from the mode commonly practised.

Upon the first of these points I have to observe, that a cheap and valuable remedy may be had in most situations, which, when mixed with the dung, will not only destroy the vermin, but, by its operation upon the manure, render it much more valuable. The article I allude t is *lime*, which, when mixed with well digested animal and vegetable manures, not only destroys every insect, or animalcule, which they contain, but by its solvent qualities accelerates putrefaction, and renders their effects upon the crop more certain and valuable.

In the 15th chapter of the great General Report, under the article of composts, and also when treating of stable dung, notice is taken of the utility of mixing lime with that manure: the ostensible reason there held out, is the benefit derived from the active qualities of the lime dissolving, and rendering active the heavy parts of the dung: of this truth, every person who has paid the slightest degree of attention to the subject is now convinced, and accordingly many of the best farmers in England employ a mixture of lime in all their manure; but when to the advantage above mentioned, is superadded the destruction of such vermin as are likely to breed in the dung, and afterwards to destroy the crop, the mixture of lime with it will appear to be one of the most beneficial improvements in modern husbandry.

Other substances, possessing similar qualities, may be successfully employed for the same purpose, such as *soapers ashes*, *bleachers ashes* or refuse, *potash*, kelp, &c.; all of which, will be found to destroy insects, and render the dung more valuable; and though neither of these articles are to be met with, in sufficient quantity to admit of their being generally used, yet as there are particular situations where they are procurable in tolerable plenty, and at a cheap rate, I have judged it necessary to mention them, especially the refsue of soap works, and bleach fields. It is necessary, however, to notice, that neither lime, nor any of these articles should be mixed with the manure till it is completely fermented, as any attempt of that kind would not only prevent fermentation, but injure the quality of dung.

Other modes of destroying the vermin might no doubt be had recourse to, such as

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mixing sea salt, arsenic, and other metallic solutions, with the dung; all, or any of which, will no doubt operate to the destruction of the insect; but when it is considered, that *hogs*, fowls, and the whole tribe of domestic animals, are in imminent danger of being destroyed by them, and also that their qualities are inimical to vegetation, every considerate man will pause before he makes trial of them, and carefully inquire whether the risk of ill consequence arising from their use may not more than counterbalance any advantage accruing therefrom. I am the more solicitous to dissuade the attempt from being made, from the consideration that the substances just mentioned. *viz.* lime, potash, &c. along with their being a safe and effectual remedy, are also good manures themselves.

Upon the second point, *viz.* a different mode of applying the manure, perhaps equal benefit might be derived from a regulation of that kind. It is known, that after well digested manure has been put into the earth, and covered up from the sun and air, that the breeding insects in it, especially the worms above noticed, goes on much faster, than in cases where the same manure is left upon, or near the surface; from thence I would infer, that if the dung, instead of being ploughed in and buried, as is commonly done for wheat crops, were applied as a top dressing in the spring, there would be infinitely less risk of its being hurtful to the crop, provided it could be proved that an equal share of nourishment was derived from it in that way.

In the 15th chapter of the General Report, I have spoke at great length upon this subject, and have there endeavoured to prove, not only from reasoning, but experiment, that immense advantage might be derived from the general use of top dressings. It is evident that much less manure will answer the purpose, and that no part of it will be lost. To which I have now to add from recent observations, that when it is applied in that way, and at a proper season (which I have elsewhere said should always be when the crop is in a growing state, and can absorb and take up the useful parts of it) there is infinitely less risk of its producing vermin.

In the paper above mentioned, notice is taken of the destructive effects of dung when it is applied upon broad clover in the autumn. I have long been acquainted with this fact, but till lately was ignorant of the cause: I am now, however, satisfied from ocular evidence, that much of the mischief done to clover plants proceeds from vermin generated in the manure, I have lately examined many fields of clover lay of one year old, upon which dung had been applied last autumn, in all of which I found either worms or small snails at the root of almost every decayed plant I met with.

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From these circumstances it appears probable, that the failure of both clover and wheat in the spring is owing to the same cause; and that a very great majority of all the plants that are thought to perish from the severity of the winter, are in fact destroyed by vermin. The effects of dung applied in the autumn upon clover lays of one year old have been taken notice of; the same thing is this year very perceptible upon the clover plants, that were sown last spring upon lands that had been fallowed the preceding summer, and well manured; in many very rich fields of that description a great destruction of the young plants has happened, evidently from worms and slugs.

I am pretty well satisfied that the evil might, in both intances, be either palliated or entirely prevented, by applying the manure upon the surface early in the spring; when used in that way for clover, it is known to succeed to admiration, and in place of destroying the plants, which it usually does when applied in autumn, it seems to strengthen them, and seldom fails to produce a rapid vegetation, and an early and valuable crop of hay.

In the trials that have been made of using manure in the form of a top dressing for wheat in the spring, the success has been very great; and there can be little doubt that a general application of it in that way, both for wheat and clover crops, would produce the most beneficial effects.

Having mentioned at some length the origin of the worms and slugs, and suggested what appears to me to be a remedy for them, I will conclude my observations with a few remarks upon the nature of the insect, which occasioned so much mischief upon the ears last summer.

This insect bears a striking resemblance to a louse, and when it is first distinguishable by the eye, is of a red colour, nearly resembling that of a boiled lobster, and so soft and tender as to be killed by the slightest pressure; as it increases in size, the colour gradually changes from red to a dirty black, when it becomes stationary, and continues so till it dies. During its growth, it also loses the soft tender texture above described and in its black state feels hard, and as if it were covered with a crust or shell upon the back.

It does not appear that this is a new insect, for most of the farmers with whom I have conversed seem well acquainted with it, and all of them assert that, if they are carefully looked for, some of them may be met with, even in the best fields of wheat, every year. It appears, however, that they are infinitely more numerous and

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destructive in late wet seasons, than in such as are earlier and more favourable. In the year 1782, for instance, when the crop was uncommonly late, and the season very wet and cold throughout, the wheat crop almost entirely failed from the depredations of the same insect; and every other instance that can be recollected of their mischievous effects, has always taken place in the latest and coldest seasons.

The observations which I made last summer confirm me in that belief: for I uniformly found that, in proportion as a field of wheat was early, the injury done was not only much less, but the number of vermin smaller, while on the contrary, as the crop was later the mischief was in the same proportion greater, and continued so throughout the season. The inference I draw from thence is, that wet seasons are more favourable to the generation of these insects than dry ones, and that though they are bred in considerable numbers even in the best years, yet they come into existence at a period of the season when the crop is too far advanced to be injured by them. This last idea was considerably strengthened by trials which I made last summer, of placing the insects upon healthy plants at different periods of their growth: when put upon plants in the flower, and while the stalks and blades were green and tender, they adhered firmly, and completely effected the destruction of the ear; but when put upon such as had made some progress towards filling the blades, and the stalks of which were beginning to harden and become tough, they not only entered upon them with more difficulty, but if the growth and filling had advanced beyond a certain period, and the blades, &c. had lost their saccharine taste, they would not remain upon them; or if they did, they died seemingly of hunger. I tried them upon several hundreds of healthy ears in this way, and with the same result I have stated, from which I think it is at least presumable, that a certain degree of hardness in the stalks and husks of the wheat is a sufficient protection against this insect; and that after the grain has past the milky state, it is beyond the reach of being injured by them.

Of Black, or Smut, in Wheat.—This distemper has been long known, not only in Britain, but other countries, and has been differently denominated in almost every different county. The name by which it is most generally known in England is *smut*, and in Scotland *black*, both of which are pretty expressive. The names that have been given to the disease in different places are not more opposite and dissimilar than the ideas that have been entertained as to the cause of it; but this is not to be wondered at, as no accurate investigation of the evil has ever been set on foot, and those who have published their sentiments upon the subject seem to have had scarce any other

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foundation for the opinions they advanced but conjecture; and in all cases where opinion has no other basis, very little dependence can be placed upon it. The principal causes assigned I shall, however, take notice of, and in the course of my observations shall prove by undeniable facts, that they are, with one exception only, totally unfounded.

1. Some have ascribed the disstemper to an insect, though without having been able to prove the existence of it.

2. It has been supposed to be owing to a weakness in the seed.

3. To the grain being wet in harvest, and a great deal of it springing.

4. To a defect in the male organs of the plant.

5. To a virulent quality in the black earthy matter contained in the *smut balls*, which operates like a ferment upon every grain it comes in contact with, and renders it unfit to produce any thing but smut.

How far any of these are entitled to credit will be seen in the sequel. That the distemper is infectious is beyond a doubt, and that it can both be prevented and cured is equally certain, and that too, by very simple means, as will be shewn by the following experiment.

Some years ago I collected a quantity of smutted ears from one field of wheat, in which they were very numerous, and a number of healthy well filled ears from another field, in which there was no smut. The grains were rubbed out of both, intimately mixed, and kept in a box for two months, at the end of which they were rubbed between the hands in such a manner as to break the whole of the smut ball. The parcel was then divided into two equal parts, one of which was three or four times washed with pure water, and well rubbed between the hands at each washing, and afterwards sown in a drill in my garden; the other half was sown in another drill without any washing or preparation whatever; the soil and every other circumstance was equal.

Both parcels vegetated at the same time, and for about two months thereafter, there was no visible difference in their appearance; about that period I observed that many of the plants in the drill, that had been sown without being washed, were of a darker colour than the others; these, when narrowly examined, were of a dirty green. The plants in the drill that had been washed were all of one colour, and seemingly healthy; as the season advanced, the difference in colour became more striking, and continued

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to increase till the grain was fairly out of the blade; about which time many of the dirty green ears began to exhibit symptoms of decay.

As soon as the ear was fairly shot out, the whole of those in the unwashed drill, that had the dirty green appearance above described, were found to contain nothing but smut; and these smutted ears were in the proportion of more than six to one of the healthy ones, while, on the contrary, the drill in which the washed grains had been sown, and which consisted of several hundred grains, had hardly a smutted or unhealthy ear in it. The same experiment was repeated the following season, and with nearly the same result. Satisfied with knowing that complete washing would be found a remedy for the disease, I made no farther inquiry upon the subject till last autumn, when I was employed in making observations upon the blight. In the course of which I met with a good deal of smut in many fields; and being at that time possessed of some excellent glasses, I carefully examined some of the smutted plants. This at first was done more as a matter of amusement, than from an expectation of discovering any thing that might contribute to throw light upon the subject. Upon a near inspection with the glass, I found that the dirty green colour of the blades of the smutted ears was owing to a number of spots infinitely small, and bearing a near resemblance to those I have described upon the blighted ears: my observations were continued throughout the whole period of the ripening, in the course of which I made no additional discovery, except observing, that the leaves and stalks of the smutted ears decayed sooner than such as were healthy.

About the end of autumn, however, having one day brought home some smutted ears of rather an unusual appearance, I examined them very narrowly, and observed that the balls were perforated in many places with small round holes, a thing I had not before observed in any that I had met with: this I ascribed to vermin, and upon sticking one of the grains upon a pin, and placing it under the glass in a very bright sun, I could distinctly observe several small transparent specks upon the beard, or downy part of it. I examined several more, and met with exactly the same appearance; but being called hastily away upon business, I was under the necessity of leaving them upon the table, without being able to ascertain whether the objects I had seen were eggs or insects.

In the evening when I came home I resumed the investigation by *candle-light*; in the course of which, as I was under the necessity of holding them very near the

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candle, the heat soon relieved me from my embarrassment, by putting them in motion, and I then discovered that the specks above mentioned were real insects, resembling wood lice in shape.

Next day I repeated the same trials by sun light with new smut balls, and discovered the same appearances, but without being able to make any of the insects stir. Disappointed and vexed at not being able to see them in motion with sun light, and recollecting the heat of the candle, I threw the concentrated rays of the sun upon them with a burning glass, which completely answered my purpose of putting them in motion, and shewing them in every different point of view.

To describe minutely an insect so small as not to be distinguishable by the naked eye would be no easy matter; it is sufficient to say, that its general appearance is very similar to the wood louse, though infinitely smaller.

As soon as I was clearly ascertained of the existence of this insect, my mind was perfectly at ease with regard to the cause of the distemper; for though I could very readily conceive that vermin in the early stages of the growth of a plant might so injure the stamina, as to render it unfit to produce any thing but smut, I could not so well understand, how it was possible for the mere touch of the black earth contained in the smut balls to produce the same effect.

It is perfectly well known, that in the animal body certain infections are communicated merely by the contact of the sound and unsound parts; but in every instance where this happens, the injury can be distinctly traced to an absorption of the virulent matter by the vessels of the healthy subject.

We are now so well acquainted with vegetation, as to know that plants have a circulating system as well as animals; and that while they are in a growing state, poison as well as nourishment may enter their vessels, and do infinite mischief. If this reasoning is sanctioned by experience, and there can be no doubt of it, and if there is the slightest analogy between animal and vegetable life, it will at once appear, that no bad effect could possibly arise from smutted and healthy ears coming in contact, either in the stack or the barn, as at that time they are in a state of rest, and no circulation going on. It may be argued in answer to this, that while the plants are green, the shaking of the wind may bring the smutted and the healthy ears into contact; and that the acrimony of the smut may corrode and destroy the healthy wheat, so as to produce the disease. This idea I know is entertained by many very good farmers: it is, however, clearly disproved by the experiment above recited, by which it appears that a simple

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washing in water, provided it is properly performed, is a very effectual cure for the distemper: common sense will inform, that had the stamina, or germ of the grains so washed, been injured by any thing of a corrosive nature, even in the slighest degree, no ablution whatever could possibly have repaired the mischief.

The same reasoning applies with equal justice to the other causes assigned, with the single exception of insects; for if either the grain was naturally weak, or had been sprung in harvest, or was deficient in its male organs, as is ridiculously supposed, nothing but the highest degree of weakness and credulity could make any person believe, that either the washing with water, or indeed any other preparation, could cure such defects.

It is my opinion that smut is occasioned by the small insect above described, as seen by the glass in the downy part of the grain; and that when the balls are either broke in the operation of thrashing, or come in contact with clean healthy grains, the insects leave the smutted grains, and, adhering to such as are healthy, are sown with them, and wound the tender stem in such a manner as to render the plant incapable of producing any thing but smut. It is not an easy matter to account for the manner in which this takes place; but a little attention to the circumstances I am now to mention will perhaps throw some light upon it.

It is known that plants of very opposite *natures* and *qualities* will grow and produce abundantly upon the same soil, where the nourishment is seemingly the same. This effect is also known to be owing to the structure of their vessels, by the action of which the juices that circulate through them are differently prepared in every different plant. From this striking difference, owing confessedly to organization, is it not presumable that the smut in wheat is produced by the insects wounding the vessels of the plant in such a manner as to render them incapable of taking up any other principle from the soil, but the smut contained in the balls, which upon examination seems to have no quality different from the finest vegetable earth?

This opinion I think is strongly supported from the circumstance of certain pickles being found a cure for the malady. The effect of these pickles is, however, completely misunderstood; for in place of supposing, as is erroneously done, that they operate by strengthening the grain, and thereby removing that debility which has been long considered as the cause of smut, their benefit depends upon the powers they possess of destroying the insects above described: but to shew the absurdity of the commonly received opinion in a more striking point of view, it is only necessary to state, that

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many of these preparations, which are supposed to be so friendly to vegetation, are in fact highly inimical to it, unless they are used with the utmost caution; even stale urine, which has long been considered as a safe and innocent remedy, is, under certain circumstances, highly pernicious.

After I had discovered the insect, I made trial of all the substances commonly used, and found all of them, when properly applied, destructive to it. Is is not therefore more agreeable to plain common sense to suppose, that the virtue of these preparations consists more in the power they have of destroying vermin, than in any strengthening quality they possess? indeed some of them, as I have just now observed, instead of possessing strengthening powers, are highly inimical to vegetation; this I shall more clearly point out, when I come to speak of the different pickles made use of.

Of Pickles.—Having thus given a distinct and candid account of the circumstances which came under my eye, in the course of an inquiry into the cause of the blight and smut in wheat, I shall now mention the remedies commonly used as preventatives, make some observations on the nature of each, and then suggest what appears to me to be the proper mode of prevention.

1. *Of the Salt Pickle.*—The salt pickle is prepared sometimes with plain water, into which common kitchen salt is put till it is of such a strength as to float an egg. In many cases, however, sea water is used, and salt added to it, till it will also carry an egg; the advantage of using sea water is, that less salt is required. The pickle, thus prepared, is put into a large open vessel, that will hold perhaps 30 or 40 gallons; the wheat is then poured into it, in the quantity of, from a bushel, to two bushels at a time, and well stirred round, either with a broom or a stick: during the stirring, the light grains rise to the surface and are skimmed off; the vessel is then lifted up, and the contents poured into another of equal dimensions, upon the mouth of which a sieve is placed; the sieve retains the grain, and suffers the pickle to pass through it into the vessel beneath. The same quantity of wheat is again put into the pickle, and the same process repeated, till the whole has been washed and pickled; and progressively as it is taken out of the water, some new slaked lime is sifted upon it. The whole is then carefully mixed up with a wooden shovel, and frequently turned over, till it attain a sufficiently degree of dryness, in which state it is committed to the earth without any further preparation.

Of the Urine Pickle.—When urine is made use of for pickling wheat, it is done in the following manner: a quantity of urine, in as stale a state as possible, is put into a

vessel, in the same manner as mentioned for the salt pickle, into which the grain is put and well stirred. The contents are then poured through a sieve, and the process continued till the whole of the wheat intended to be sown is moistened. It is then sprinkled with lime, as was mentioned for the salt pickle, and committed to the earth.

In many cases, however, instead of mixing the whole of the grain with the urine, as above described, it is common to spread the wheat upon the barn floor, and sprinkle the urine upon it, either with a watering pan, or a kind of brush made of straw, and when it is sufficiently moistened, lime is added, as before described, and the grain sown.

A third pickle has been proposed to the Board of Agriculture by an ingenious Italian physician, J. B. Scandella, which I shall distinguish by the name of the Italian pickle.

Italian Pickle.—Take of nitre, three pounds; alum, one pound; vitriol, six ounces; verdigrise, three ounces; wood-ashes well sifted, six pounds; boil the whole in a copper with five pails of water for an hour, then remove them from the fire, and pour them into a large vessel; then add sixteen pails of water, in which half a bushel of quick lime has been previously dissolved; mix the whole intimately, and allow them to stand till they are quite cold. In this steep, two bushels and a half of wheat are to be plunged, and left for about six hours, stirring it up frequently with a wooden shovel, and skimming off what rises to the surface; the wheat is then to be withdrawn, and spread out till it is dry enough for sowing. The process is thus to be continued until the whole quantity of seed intended to be sown is pickled. The above steep is generally sufficient for preparing about twenty-four bushels of wheat.

Observations.—Upon the first of these preparations, namely, the salt pickle, I have to remark, that as far as my own observation, aided by the testimony of the most respectable farmers, can be depended upon, it has never been known to fail in a single instance, where it has been judiciously applied; that is to say, it has always prevented the crop from suffering by smut. But though it has answered this purpose most effectually, and the proofs in favour of it are too numerous to be disputed, there is little doubt, that under certain circumstances it may be highly injurious to the crop.

While the grain steeped in this pickle continues in a moist state, it may be kept for any length of time, without much injury to its vegetative powers; a circumstance of no small consequence, as it not unfrequently happens, that after the grain has been pickled and made ready for sowing, a sudden fall of rain prevents it from being put

into the earth for several *days*, perhaps *weeks*. But though the pickle is thus harmless while the grain continues in a moist state, repeated trials convince me, that it is quite otherwise when well dried and exposed to a certain degree of heat. I do not hazard this merely as an opinion, but speak from conviction, when I say that if wheat, which has undergone this preparation, and has had lime in a very active state mixed with it is sown early in the autumn, (say in August,) upon dry warm land, and no rain falls for a considerable time after, a thing by no means uncommon at that season of the year, a great proportion of the grain will be either entirely destroyed, or materially injured by the dry caustic crust with which it is surrounded: the mischief in this case is certainly done by the action of the lime, and in many instances is very considerable.

It will naturally occur as a question with many farmers, how is this evil to be avoided? Steeping the grain in a salt pickle, and mixing it with lime, is known to be an effectual remedy for smut; and are we to forgo the use of a preparation, which we know from experience to be a cure for a certain evil, for the bare chance of the grain suffering afterwards from drought?

The objection is plausible, and demands investigation. From much conversation upon the subject with experienced, and scientific farmers, and numerous trials of my own, I am perfectly satisfied, that the most valuable part of this preparation consists in immersing the wheat in the *brine*, and that the lime is only added afterwards as an absorbent to dry up the superfluous part of the moisture, and make the grains separate and sow more readily: if this is admitted, and it certainly is the case, I think it will be extremely easy to reap the whole benefit of the salt pickle without any of its defects, merely by substituting some other article in the place of lime, and for that purpose nothing seems better calculated than powdered chalk, or common whitening. The former is known, in its unburnt state, to be entirely destitute of any caustic or corrosive quality; and the latter consists of burnt limestone, which has been completely saturated with moisture, and afterwards dried, by which process its activity is destroyed; both of these articles can be obtained in sufficient quantity in most situations, and as neither of them are expensive, they will be found good substitutes for lime, and if properly managed will answer every purpose that can be expected from it, without the smallest degree of risk.

With regard to the urine pickle, I have to observe, that there is no article at present employed, that requires to be used with more circumspection; nor is there any where

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the risk or loss attending its use has a chance of being so great. I am ready to admit, that where the urine is sufficiently stale, and the grain properly moistened with it, every insect, or animalcule, contained therein, will be completely destroyed; but to counterbalance this, I have to state, that as yet there has been no test established to ascertain the necessary degree of staleness; and as it is known, that urine which is not stale will not destroy vermin, there is an absolute certainty, if it is used in that state, it will be of no service.

On the other hand, when urine is completely stale, it abounds with volatile alkali, which, in its naked state, is known to be hurtful, when applied either to seeds or plants; but when united with lime, it then forms what is called caustic alkali, in which state its strength and dangerous qualities are very considerably increased. This compound, though an excellent manure when applied to the soil, and allowed to operate properly upon it before the crop is sown, is completely destructive both to seeds and plants when brought into contact with them. When wheat therefore has been completely moistened with urine, and is afterwards mixed with quick lime, the crust with which it is surrounded will be of the most acrid nature, and nothing but throwing the seed immediately into a tolerably moist soil can possibly save it from destruction. Accordingly it has often happened, when wheat pickled in this way has, by bad weather or any other accident, been prevented from being sown, even for a single night, nine tenths of the seed have been known to perish. I have said that nothing can save the seed thus crusted over from destruction but sowing it instantly upon land containing a certain share of moisture: if the soil happens, however, to be of a warm nature, is very dry at the time of sowing, and the weather continue warm and dry for any considerable time afterwards, an immense deal of the seed will perish by the action of the pickle.

The above objections to the urine pickle, which every man who is in the slightest degree acquainted with its chemical properties will readily understand, apply to those cases where the pickle has been most faithfully prepared and adminstered, and that is, when the grain has been completely immersed in it. The other method, *viz.* that of laying the wheat upon the barn floor, and sprinkling it with a wisp of straw dipt in the urine, is also liable to many objections. I have already hinted, that we have at present no test for ascertaining the necessary degree of staleness in urine; the want of this must always subject the use of it to very great uncertainty; but admitting that it were in all cases sufficiently stale, there is no possibility of applying it properly, or equally,

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when the wheat is spread upon the floor; some of it will have more moisture than it requires, some will be very imperfecly moistened, and many of the grains will not be moistened at all: I need scarcely add what the consequences of such management will be. The part of the seed, which has got an overdose, will be subjected to all the risks I have mentioned, from the caustic quality of the urine and lime; and the remaining part, which has been either imperfectly moistened, or not moistened at all, will, by the vermin not being destroyed, produce blighted, or smutted ears. When speaking of the salt pickle, I have said, that if powdered chalk, or common whitening are used, it will destroy the insects as effectually as lime, and that without the least risk to the grain, and have accordingly recommended it to be prepared in that way. The urine pickle I decidedly condemn, as it is in every point of view liable to insuperable objections; for whether the urine is used singly, or in conjunction with lime, great mischief may be done by it, if the wheat is either prevented by any accident from being sown, even for a single night, or if it is sown upon dry land, and the weather continues warm, and no rain falls for a considerable time afterwards; but if the urine pickle is ever had recourse to, it will certainly be much milder, if chalk, or whitening, are employed as absorbents in place of lime.

I am fully sensible, that much opposition will be made to the doctrine here laid down concerning these pickles, especially by those who have been long accustomed to the use of them; and who, without knowing the risk with which they are attended, have generally ascribed the failure, or deficiency of their wheat crop to other causes; but the ideas here held forth are by no means the offspring of conjecture or a warm imagination; careful trials have been made of each, under almost every variety of circumstances that can occur, with this result; that though in a few fortunate cases, both the salt and urine pickles may be used without any seeming loss or inconvenience, yet in a majority of all the instances in which they are employed, more or less of the seed perishes from their effects.

For several years past I have made trials of both pickles upon a given number of seeds sown at different periods of the season, and under different circumstances of heat and moisture, and I have uniformly found that when wheat pickled with salt and lime was sown either upon ground containing a moderate share of moisture, or had a light shower soon after it was sown, scarcely one grain in ten perished; whereas, when it was sown upon warm dry land, and no rain fell for perhaps two or three weeks afterward, nearly a third of the seed never vegetated.

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Again, when the urine pickle was used, even under the most fortunate circumstances, two grains out of ten, or one fifth part of the whole, was generally the least failure that happened, even when it was sown immediately after being pickled, but in cases where it was kept a night or two in the pickle, nine tenths of the seed have been known to perish, and when sown upon very dry land, and much dry warm weather followed, the loss has also been very great. The trials here mentioned having been made with a given number of grains, I was enabled to acertain, with perfect accuracy, the proportion which perished in each experiment. These trials, with their dates, would have been detailed at full length, but as this paper has already exceeded the limits originally intended, I have omitted them.

Probable cause of the increase of Insects, both amongst wheat and other grain.— Experience, in many instances dearly earned, has clearly proved, that particular seasons are more favourable to the increase of insects than others; but though certain kinds of weather may be favourable to their propagation, it will be found, upon inquiry, much of the evil is in general owing to the carelessness and inattention of farmers. It is a circumstance now pretty generally known, and well ascertained, that the whole of the insects that are hurtful to the different crops die every winter, and that their different kinds are kept up by eggs which come into existence the following summer. These eggs are generally deposited either in the chaff, or in the beard or downy part of the grain, by which means nearly the whole breed is brought home with the crop every year, and could with very small trouble on the part of the farmer be completely destroyed. No attention, however, is paid to this point; and by a neglect that is culpable in the highest degree, they are suffered to breed from year to year, to the manifest injury, and sometimes total ruin of the crop.

I have long observed with pain the ordinary way of separating the grain from the chaff: this operation is for the most part performed in the most shameful manner, the fanners being generally placed so near the barn door, as to blow the whole of the chaff into the dung-yard; by which means not only the seeds of all the different kinds of annual weeds that grew amongst the crop, but also the eggs of those insects that are known to be destructive to the grain, and which have been either deposited in the chaff, or mixed with it in the operation of thrashing, are put amongst the dung, the warmth and nourishment of which, is highly favourable to their propagation. In that way, the weeds and vermin of one season are again committed to the earth, where they multiply beyond conception, and destroy the crops of the succeeding year, and prove an endless

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source of mischief. Any person who pays the slightest attention to the subject, will readily understand what affects must necessarily result from such management. Indeed the evil soon manifests itself: for by the time the dung has lain a very few days in the field, especially if it has been spread, and the weather warm and moderately moist, myriads both of vermin and weeds are discoverable in it: but what puts it beyond a dispute, that the eggs of these vermin are carried to the fields in the manner abovementioned, is, that in all cases where any material injury is done by them, it is to crops that have been well manured. Another very strong proof in support of this opinion is, that if the sweepings of a barn, in which smutty wheat has been thrashed, is mixed with dung, and laid upon land where wheat is to be sown, the crop will infallibly be tainted with the disease. Trials of this have been made; and in some instances, four fifths of the plants sown where the dung so mixed was laid, produced nothing but smut balls.

Instead of this practice, than which nothing can be more reprehensible, the whole of the chaff and dust that is separated from the grain in the act of cleaning, should be carefully collected and burnt; and in order to insure complete success to a measure of this kind, the walls and roof of every barn should be smooth plaistered; the fanners, during the operation of cleaning should be placed in such a manner as to blow the whole of the chaff, &c. into a corner by itself; and when the whole is cleaned, the roof, walls, and floor, should be completely swept into the corner amongst the chaff, and the whole carefully collected into a sack, and carried out during calm weather, and burnt. Were a measure of this kind generally adopted and duly persevered in, there can be little doubt that the greatest part of the mischief which has been so long done, both by vermin and weeds, would cease to be felt.

I have frequently observed with regret, farmers, who have bestowed great labour and expence in fallowing and cleaning their fields, completely ruin them immediately afterwards, by manuring the fallow crop with dung, with which the whole of the weeds and insects, or animalcules, of the preceding crop was mixed.

It is well known how readily both men and other animals are hurt by vermin, and with what difficulty they are rendered clean: it is also known, that when they are freed from them, they will continue always so, unless some tainted animal is introduced amongst them. The same thing applies to grain: sow healthy seed upon land that has been manured with dung in which there were no insects or eggs, stack the produce

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at a distance from any tainted grain, and thrash it in a clean barn, and it will continue healthy for ever; but the cleanest seed, when sown upon a field where there are myriads of insects amongst the dung, or thrashed in a barn that has not been properly cleaned, after having foul or smutty grain in it, will infallibly become diseased. The most ignorant peasant knows, that any person who ventures to wear the clothes of another, who has had a certain *cutaneous disorder*, will certainly catch it: the disorder I mean, is occasioned by vermin. It is rather wonderful that this hint has not been taken by farmers. The infection above alluded to is not more catching than the diseases to which grain are liable, and every thing that has the most distant tendency to introduce them, should be shunned with as much care as the pestilence.

I am sensible that it will be no easy matter to convince many farmers, either of the mischief arising from the present practice, or the benefit that will result from the measure I have proposed; to such I have only to observe, that the perverseness and obstinacy of the Turks have perpetuated that dreadful distemper, the plague, amongst them; a disease, which by proper precautions has been long extinct in Europe, and which, by the same means, might also have been banished from Turkey: a similar obstinacy on their part will have an equal tendency to perpetuate an evil, which, with very small trouble and attention, may be remedied, and the prevention of which will produce immediate emolument to themselves, and great benefit to the community.

Letters addresed to Sir John Sinclair, *Bart. President of the Honourable Board of Agriculture, on the Subject of the Blight in Wheat, and published in the English and Scots Papers, in October* 1795.

LETTER I.

Sir, Haddington, October, 1795.

The ardent zeal you have discovered in acquiring and disseminating useful knowledge, convince me that any hint, however imperfect, that has a tendency even in the remotest degree to promote the public good, will be favourably received.

Having paid particular attention to the blight, which has affected the wheat this

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summer, I beg leave to offer the following hints to farmers, for the management of their seed.

The disease is known to have arisen from an insect, which, by wounding the ear in several places, has in some instances destroyed it entirely, in others one half of it only has suffered, and in many cases only a few grains have been hurt; while in a great majority, though the injury has not been such as to destroy, or render the ears entirely empty, yet by checking their growth after they had made some progress in filling, they have ripened prematurely, and when rubbed out, the grain contained in them is found to be hungry and imperfect.

From the immense number of these insects discoverable upon the wheat, there is every probability that many of their eggs may be deposited, either in the chaff, or downy part of the grain, which, if sown along with the seed, will, by preying upon the tender stem, either destroy it entirely, or make it produce smut balls; to prevent which, complete washing in pure water should be had recourse to, in the following manner:

Take a tub, or large open vessel, place it under a pump, put into it a bushel or two of the wheat intended to be sown, fill it up with pure water, and stir it well for *five* or *six* minutes with a *broom*, or *birch besom*, carefully skimming off every light grain; then pour the water off, and repeat the operation with fresh water, till no more light grains rise to the top, and till the water made use of, takes no dirty tinge from the wheat. When this operation is carefully performed, not only the light imperfect grains will be separated from the seed, but also the greatest part of the eggs of the vermin, and the succeeding crop will in all probability be healthy. Such a precaution is peculiarly requisite this year, as from the scarcity and high price of wheat, the greatest part of the seed will be taken from the new crop.

I am, &c.

A FRIEND TO AGRICULTURE.

Sir John Sinclair, Bart. M. P.
President of the Board of Agriculture.

After the publication of the above letter, I continued my observations, and was soon convinced that what I had there hinted, with regard to the eggs of the insects being deposited in the downy part of the grain, was but too true; by the assistance of

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a good glass I discovered many of them, as already mentioned in the beginning of this paper. In consequence of which I published the following, addressed also to the President of the Board.

LETTER II.

Haddington, October, 1795.

SIR,

About two weeks ago I took the liberty of addressing you on the subject of the blight in wheat; at that time I mentioned the cause of the mischief, and recommended frequent washings in pure water as a measure calculated, not only to separate the hungry imperfect grains, but also to wash off such of the eggs, or young insects, as might adhere to the healthy seed. From a very careful examination of the grain, I am now enabled to say, that many of these eggs are deposited upon the *down*, or *beard*; these adhere so firmly as to cause a suspicion that some of them may remain, even after repeated washings. To destroy these effectually, some preparation will be necessary. The mineral kingdom, it is well known, abounds with articles, whose deleterious effects are fatal, not only to insects, but the largest animals; but the whole, or the greatest part of that class of remedies hitherto recommended, are of a nature so acrid and corrosive, that there is an almost absolute certainty of their destroying the grain at the same time that they kill the vermin; even the ordinary preparation of *stale urine* is dangerous; for if by any accident the seed is prevented from being put into the ground, even for a single night after it is pickled, nearly the whole of it will be destroyed. The risk and disadvantage attending the use, both of the urine and other pickles, led me to examine the vegetable kingd om for articles, whose effects would be completely destructive to the insects, without injuring the grain. After many trials I found the following preparation quite sufficient for that purpose.

Take of *Barbadoes aloes, tobacco,* and *hellebore powder*, each one pound; boil the tobacco and hellebore powder, for about an hour and a half, in ten English gallons of water, then strain it through a sieve, with a cloth laid over it to separate the tobacco, &c.; put the strained liquid again into the vessel, replace it upon the fire, and stir the *aoles* finely powdered into it; let it boil till the *aloes* are completely dissolved, then remove it from the fire, and suffer it to cool; when cold, pour it into a large tub, and add as much pure water as will make thirty gallons of the whole.

Into this liquid, the seed wheat should be put, after it has undergone the washings formerly mentioned in simple water, and suffered to remain at least 20 minutes, when it should be taken out and spread thin, either upon a canvass, or the floor to dry it. If a couple of pounds of coarse glue, or gum arabic, have been disolved in the mixture, so much the better, as it will by its tenacity make the bitter ingredients adhere more firmly to the grain. The use of lime as an absorbent for hastening the drying is bad, as from the combination it forms with certain articles, it is liable to injure the seed by its caustic qualities.

The above articles will seldom exceed seven or eight shillings; and when properly prepared, and carefully applied, will be found sufficient for twelve bolls of wheat. The preparation which I have thus ventured to recommend, at the same time that it is completely destructive to insects, possesses no quality that can hurt vegetation; and what is of singular importance, it renders the grain so nauseous, that neither pigeons, nor any of the devouring tribe, will eat of it. I have repeatedly given it to hens, pigeons, &c. when thus prepared, and they uniformly spit it out after tasting it. I also tried it repeatedly upon the insects that destroyed the wheat this summer, as well as others of the same description, and in every instance, even a weak solution of it was fatal to them.

I am, &c.

A FRIEND TO AGRICULTURE.

Sir John Sinclair, Bart. M. P.
President of the Board of Agriculture.

In addition to the above, I have to observe, that *chamomile*, *wormwood*, *rue*, and the whole class of bitter nauseous herbs, may be advantageously used for the same purpose; as it is uniformly found, that no insect will touch any thing that has either come in contact, or is impregnated with their juice.

Proposed Remedy for destroying Vermin upon the growing Crop.—Last season, when I was busied in making observations upon the blight, &c. my ideas in the way of cure, or prevention, carried me no farther than the preparation of the seed: after much reflection upon the subject, I am now however, convinced, that the vermin may be destroyed, and the disease cured, upon the growing crop, and that too by very simple means. The method I propose is this; take a piece of double flannel of about two yards in breadth, and of a length sufficient to go across a ridge; let a couple of cords be fixed to the flannel, one at each end for a man to hold by, in the manner

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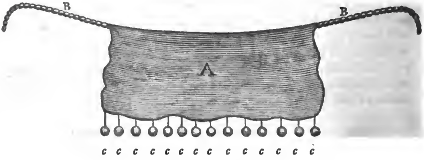
represented in the sketch, and let little bits of lead, at proper distances, similar to what are put at the bottom of fishing nets to keep them low in the water, be hung to the other side of it.



EXPLANATION.

A The flannel. B B The cords. *c c c*, &c. The weights.

The above rude figure represents the flannel so prepared: let this be dipt in a preparation similar to that recommended in the last letter: after being properly dipt, let a person take hold of the cord at each end, and go into the furrow at each side of the ridge; let them go on, in the direction of the ridge, drawing the flannel after them; in their progress it will touch the top of every plant upon the ridge: when they have drawn the flannel in this way from one end of the ridge to the other, let it be again dipt in the same materials, and drawn a second time along the ridge; in that way both sides of the ear will be touched by the flannel; this operation should, if possible, be done during dry weather, for this obvious reason, that any part of the nauseous ingredients which may be left upon the ears by the flannel, will adhere more firmly than they would do, when they are wet, or during rain, which would be ready to wash them off entirely. I am sensible that considerable doubts will arise, as to the utility of such a measure, and that it will be imagined by many, that the small portion of the ingredients left upon each grain will be very inadequate to the end proposed; but whoever considers the nature of the smaller insects, and the nice sense which they possess, both in smelling and tasting, will be satisfied that even the smallest portion of the wash above mentioned adhering to the ears will protect them sufficiently from farther

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mischief. Indeed, I convinced myself of this beyond a doubt last summer, for upon drawing a linen rag that had been moistened in a very weak solution of aloes lightly over a few ears of wheat, and afterwards laying those ears upon a tree, where there were above a hundred of the insects, in a strong healthy state, not one of them would touch them, while they at the same time fastened greedily upon a few ears that had not been toucced with the *aloes*. If this mode of curing the growing crop is found to succeed upon the great scale, immense benefit will be derived from it, in unfortunate years, such as last; the trial is certainly worth making, and what forms a strong inducement, the apparatus is simple, and the expence small, as, in all probability, it would not exceed a shilling an acre.

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XII.

Experiment to ascertain the Efficacy of MR. DAVIS's *new Method of cleaning Smutty Wheat.*

Extract from the Minutes of the Board of Agriculture.

May 29th, 1798.

READ a letter from Mr. Robinson, his Majesty's Bailiff, on Mr. Davis's method of cleaning smutty wheat, and attended the experiment, Mr. Davis being in waiting. In nine minutes he cleaned the wheat received from his Majesty's farm, so as to make it saleable at a common price; but friction in the same degree, without his powder, would not have the effect. Mr. Davis informed the Board, that the expence of cleaning a load would not, to a farmer with proper conveniences, cost more than *7s. 6d.*

The Secretary receiving instructions from the President to shew the samples to a mealman, he had an opportunity of laying them, directly, before Mr. Joseph Bell, miller, flour-factor, and baker, of No. 86, Watling-street, who, on examining them carefully, pronounced that the black wheat was not worth more than 35*s.* a quarter; that the sample treated with friction only, was worth 40*s.* but still fit only for *blues*, of which gingerbread is made; but that the sample fully wrought with Mr. Davis's powder, was a very good sample of wheat, and now worth about 54*s.* a quarter.

RESOLVED,

That it appears to the Board, that the discovery of Mr. Davis is very practicable on any scale; effective; highly useful, and important; and that he deserves the encouragement of all farmers.

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XIII.

Observations on Embankments, explaining the Nature and Construction of those calculated for reclaiming Lands from the Sea, from Rivers, and from Lakes, or for preventing Encroachments, and guarding against Inundations; with Remarks on some Embankments already executed. By Robert Beatson, *of Kilrie, Esq. late of His Majesty's Corps of Royal Engineers.*

EMBANKMENTS.

SECTION I.

Of Embanking in general.

There are many parts of the kingdom where wonderful improvements may be made by embankments, provided they are judiciously planned and properly exectuted. Immense tracts of valuable land may be gained, not only from the sea, but from large rivers and lakes; and the advantages that would accrue, even by preventing many of those rivers from overflowing their banks, and in great floods inundating the whole adjacent level country, are too manifest to require illustration.

In some places, a bank of only three or four feet in height might, at a very small expence, prevent thousands of acres being overflown, whole crops being carried off, and an immense deal of other damage being done. In other parts, very trifling banks might be the means of gaining very large tracts of country, which, in their present state are perhaps of little or no value: and yet, so indifferent are most people about improvements of this nature, that although extensive tracts are overflown, and the most serious devastations committed year after year, they use no means whatever to prevent it; nay, although the sea itself, as if to rouse the slothful from their slumbers, presents to their view, twice every four and twenty hours, large tracts that might by proper means be made of great value; yet, even these reapeated invitations are

disregarded, and no attempts are made to possess what might, in many cases, be so easily and so advantageously acquired.

There is something so truly inconsistent and unaccountable in this mode of conduct, that it is a very difficult matter to reconcile it either to common sense, or to reason. It is not, that people in general seem blind to the value of land, for in most cases they appear to be sufficiently tenacious of property, and to put a tolerably high value upon it after they do acquire it; but one would almost be led to believe, that the generality of mankind feel a much greater pleasure and satisfaction in seizing upon the property of others, however distant it may be, than to use the means in their power, of taking possession of what lies almost within their grasp; else how can we account for the strange infatuation of their encountering the utmost difficulties and dangers, risking and losing vast numbers of valuable lives, and expending immense sums of money in acquiring (although not sure of keeping) a small spot of land in a distant and inhospitable region, when at the same time a tenth, nay, sometimes an hundredth part of the sum thus expended, would gain, without any risk or difficulty, perhaps as much of a more fertile soil, on the shores of our own island, or the banks of its rivers. And surely there can be no doubt, but an additional county, or tract of land, added to the island of Great Britain, contiguous to, or within its own bounds, would, if properly cultivated, be of more permanent advantage to the nation at large, than double the quantity, in most cases, gained in a distant clime; consequently, although the possession of some colonies, or foreign settlements, is no doubt an object of the utmost importance to trade and commerce, and highly deserving of the greatest attention; yet the acquiring of additional territory at home is an object no less important, and ought therefore to have at least a share of that attention and expence bestowed upon it, which it so justly deserves.

In some places, it is true, active and enterprizing people have taken advantage of the opportunities that have offered. In Yorkshire, in Lincolnshire, in Cambridgeshire, and in other places, many hundred thousands of acres have been gained by embanking. In Holland, the whole country has in a great measure been gained in this way. Near Chester, the River Dee Company have also gained some thousands of acres from the sea, which are now divided into several beautiful farms, one of which pays a rent of £500. per annum. The others are smaller, but the whole together amount to more than £2000. per annum; forming a very pretty estate, neatly inclosed, and subdivided by thriving hedges into square or rectangular fields.

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Large sums have been expended in some places by individuals, with a view of guarding against inundations; but owing to the embankments they have made, being injudiciously placed, and as badly constructed, the desired effect has not always been produced, particularly in the northern parts of Cheshire, on the banks of the river Mersey, where embankments have been thrown up at a great expence, which, from the manner they are placed, may in some cases, by confining the course of the river, do more harm than good.

By the appearance of that part of the country, so far as I could judge from the cursory view I had of it, it seemed to me, the inundations from that river might have been effectually prevented at a much easier rate, if a proper method had been taken at first: but from a certain ill judged and mistaken tenaciousness of property, the embankments are reared so close upon the sides of the river, that in many places it is confined to a space not more than twenty yards over. Owing to this, and to an aqueduct across the river, with only one arch instead of two, which it ought, at least, to have had, the water, sometimes, in great floods, rises, I was informed, to the height of about twenty feet above its ordinary level, and overflows the embankments, although now, by frequent additions, they are about that height.

Instead of twenty yards, had these embankments been eighty or a hundred yards distant from each other, and the river widened in the narrowest places, one third or one fourth of their present height would have been quite sufficient. They would have been much easier constructed, and less liable to damage by the floods, and a great deal of money would have been saved, not only in the first construction, but in keeping the banks afterwards in repair; neither would that space of ground between the embankments and the river be altogether useless. On the contrary, it would have produced the richest pasture, or meadow hay, by its frequent manurings with the fertilizing particles left upon it, when flooded by the swelling of the river; and, in those places, if any, that are unfit for pasture or hay, willows or other aquatics might have been planted to great advantage, and thus it might have been of more value perhaps than at present, and the interior grounds more effectually secured from the ravages occasioned by a sudden flood.

Notwithstanding the general indolence shown in most parts of the country respecting the acquisition of land by embanking, and the seeming aversion that most people have to engage in such undertakings, there have been, however, some ingenious and enterprising projectors, whose ideas upon that subject have soared far beyond the

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bounds allotted to common understandings. From the speculations of such people the most important advantages are sometimes produced; and surely the man, who is possessed of a speculative turn of mind, and who considers no obstacles insurmountable, is a much more useful member of society, than he who is perpetually starting difficulties against every new project, and is for all things remaining *in statu quo*, that is, for leaving the world as he found it.

The idea of embanking Lancaster Sands, for example, never would have occurred to a torpid genius of this kind. A thousand difficulties and impossibilities would have immediately started up at such a proposal, which, to a more expanded mind, appear perfectly practicable to overcome.

What then must those *anti-projectors* think, when they are told that it is proposed to exclude the sea entirely from these extensive sands, which form a bay, exposed to a south-westerly wind, more than ten miles across, containing a surface of near forty thousand acres, and where the tide rises about fourteen to eighteen feet perpendicular height.

Some proposals and estimates have already been made for carrying this project into execution. One very public spirited and enterprising gentleman (Mr. Wilkinson) has offered to begin a subscription for that purpose, by leading off with the princely sum of £50,000: but so many unexpected obstacles have come in the way, I understand, by the claims of lords of the manors, and in proportioning the tythes, in the event of acquiring so large a tract of country, that few people have on that account chose to embark their fortunes in this immense undertaking, seeing that their profits may be liable to so many deductions; consequently nothing conclusive has yet been done in it.

Ulverstone and Duddon Sands, on the same coast, are also proposed to be embanked. The latter, over which I went with Major Gilpin, a gentleman who has paid great attention to that business, appears to be the most practicable.

According to his opinion, there might be about nine hundred acres of very good land gained there, by laying out a sum not much exceeding £20,000. If on a correct survey being made by persons properly skilled in such undertakings, so valuable an acquisition is proved to be attainable at so small an expence, can there be the least hesitation, about immediately commencing a project so highly advantageous to that part of the country, and to every individual concerned in it? But I shall speak more particularly of these sands afterwards, when treating of embankments against the sea.

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I mention them here, in a general point of view, chiefly to arouse the attention of those, who have the good fortune to be situated near places of a like nature, or such as are capable of so great an improvement, and to show that even a tempestuous sea rolling into a bay ten miles across, is not always considered as an obstacle altogether insurmountable.

That there are many large tracts in different parts of the kingdom, both on the sea coast, and on the sides of lakes and rivers, much more easily attainable than Lancaster Sands, or any of those sands here mentioned, there cannot be the smallest doubt; it is therefore surely worth the attention of those, who are so fortunate as to possess property near such places, to take the advice of the most intelligent people, upon so important a subject, that they may form a judgment, whether the acquiring of a large addition to their estates, in this manner, is an object adequate to the expence.

SECTION II.

Embanking against the Sea.

Embankments for the protection or reclaiming of land may be divided into three different kinds, namely, embankments against the sea, against rivers, and against lakes, each of which should be formed according to the resistances required. The first of these, however, will in general require by far the strongest and most expensive works.

When an embankment is proposed to be made against the encroachments of the sea, it must first be considered, what is the greatest depth of water at the highest spring tides. About two feet higher than that should be the summit of the bank. Some have recommended only one foot higher, but it is best to err on the safe side, for the consequences attending an overflow, after the whole is completed, may, in one tide, do a great deal more damage than all the expence of the additional foot in height. This actually happened near Chester, several years after the embankments had been completed. An uncommon high spring tide flowed over the top of them, and occasioned the greatest consternation through every farm: fortunately, however, it soon subsided without doing so much damage as was at first apprehended; but the embankments were immediately raised higher, and no such accident has since happened.

If the embankment is made at first, even three feet higher than the highest rise of

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the tide, especially at those places, exposed to the waves or swell of the sea, it will be so much the more secure, for new works of this kind always subside, or settle in some degree, after they are erected.

It is a very necessary precaution, particularly if the banks are large, to take the levels frequently for some time after they are completed, lest they should subside too much, and thereby occasion a mischief, which, it was imagined, had been sufficiently guarded against. If the banks are but low, this precaution is not so necessary, for the settling will always be more or less according to their height, and in low banks will be but very little.

It is hardly possible to give one general rule respecting the size and dimensions of such embankments. This must be regulated according to circumstances and situation, for which a skilful engineer will always make the proper allowances.

If the embankment to be made is to exclude the sea from a low marshy piece of ground, over which it flows only at spring tides, the operation is easy, and may be effected at a small expence. If it is intended to reclaim a piece of land that is covered every tide, either in some bay or creek, or on the sides or windings of some large river, in which the tide ebbs and flows, the work will be somewhat more difficult, in proportion to the depth of the water and the rapidity of the current.

If it is proposed to exclude the sea from some exposed situation, either at the mouth of a river, or in a bay or inlet uncovered every tide, the work will be the most difficult and most expensive of all, in proportion to its exposure to prevailing winds and to the depth of water to be resisted. Each of these situations require a different mode of management.

Embanking against the sea, if at any considerable distance within high water mark, is not only the most tedious, but the most difficult of all; for if the materials are not very good, and the work is not properly performed, the force of the water at every flowing of the tide will soon undo all that has been done, especially if the soil is of a sandy nature, as it often is in such situations. If it is a strong clay, as is sometimes the case in marshy places, there will be the less risk of its being washed away.

In sandy situations it has by some been recommended to lay bundles of straw, or reeds well fastened down, or any other impediment, to prevent the soil being carried away by the ebbing tide.

Where a sufficient quantity of good strong turf cannot be had, then expedients may be tried; but where such turf is to be got, as in most marshy situations, and where the

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Fig.1.

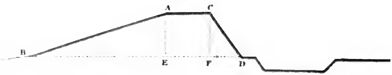


Fig.3.

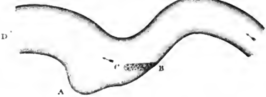


Fig.3.

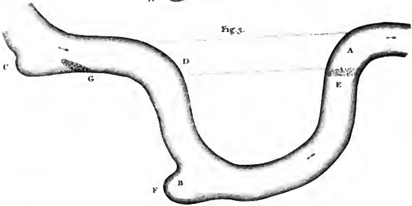


Fig.4.

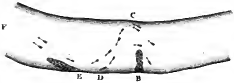
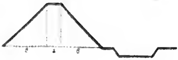


Fig.5.



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embankment required is not to exceed the height of four or five feet, it is best to finish the slope with good turf as expeditiously as possible, as the embankment proceeds; that is, supposing a length of thirty, forty, or fifty feet, or yards, of it can be completed in a tide, it is better to finish that length to its intended height, than to trace out or begin a greater extent than can be finished before the tide returns, by which a great deal of the soil might be carried away, and of the work demolished, which it is not so likely will be the case, when the slope is finished.

Turf, containing the roots of bent or rushes, is very good for this purpose. The first thing, however, to be done in an embankment of this sort is, to stake out the intended line of it, marking the breadth at the base, also the width of the excavation, or trench, to be made in the inside, from which most of the materials that compose the bank are to be taken; this trench also serves as a drain to keep dry, the grounds within. At different parts of it, should be trunks, or sluices, to shut of themselves against any external water, and to open, when the tide ebbs, to let out any water from within. Its width must be proportioned to the quantity of materials required from it, for the embankment; eight, ten, or fifteen feet wide, and three or four feet deep, leaving a *berme*, or space, between the edge of the trench and inner bottom of the embankment. If the soil is strong, one foot or eighteen inches will be sufficient for this *berme*; if it is loose or sandy, it will require at least three or four feet.

The more gradual and easy the external slope is made, the resistance against the sea will of course be the less sudden, and the embankments less liable to injury: this slope must therefore be made according to its exposure to the winds and tides, but nothing can be a greater error than to make it too bold or upright. Suppose Plate XVI. fig. 1. to be the section of an embankment of this kind; the horrizontal, or base line, EB, should be at least three times the perpendicular height AE, but FD, the inside slope, need not to be above three fourths of the perpendicular height, that is nine inches for every foot in height.

The inside slope should also be faced with turf, which may be laid with the green side downwards, as in building any common sod wall. Some expert sodders can finish this kind of work extremely neat, by setting the sod on edge according to the slope intended to be given, and with proper mallets and beetles they ram the earth hard behind, which consolidates the work as it advances, and tends very much to its durability. When the first or lower course is finished, they pare the uper edge of the sods with a sharp knife, quite even, by laying a rule to them, and then they go on with

the second course, which they finish in the same manner, and so proceed till the whole height is completed, which, when finished properly, looks very beautiful and smooth, not a joint between the turfs being seen.

If turf is to be used in covering the outside slope, it must all be laid with the grass uppermost, and well beaten down with a flat sod beetle for that purpose, and for their better security it may not be amiss to drive a small stake of about 18 inches long, or more, through every sod. The sods for this purpose should at first be carefully taken up, and traced by a line, all of the same breadth, and their edges cut as even as possible, that they may make the closer joints, which will tend very much to their security till they grow properly together.

If it is proposed to reclaim a piece of land upon which the sea ebbs and flows every tide, to a greater depth than in the forgoing case, as in a creek, or on the side of a large river; a different mode of proceeding must be adopted, according to the soil and to the materials intended to be used. If there are plenty of stones to be easily had, a bulwark may be formed of these, with a mixture of clay, either by land carriage or (which in some cases is preferable) by carrying them in flat bottomed boats, or punts, and throwing them over board till a bank is accumulated. If stones cannot so easily be had, a quantity of clay, or other materials fit for the purpose, thrown in, in the same manner, may answer equally well.

I think I have heard, that most of the embankments in Holland were done in this manner, by carrying the clay dug out of the canals in boats, and throwing it into the water. In either case it is necessary to fix up strong poles before the work is begun as guides for laying down the materials. Sluices are also requisite at certain places, to let out the back water when the tide ebbs; but the position and construction of these depend so much on local circumstances, that the engineer who conducts the work ought to be the best judge where and how to form them.

A great deal depends on a skilful engineer in works of this kind, who will contrive many ways to facilitate the work, and to overcome all difficulties in the execution of it. A man of real genius, by his different contrivances, will often render the accomplishment of a great undertaking comparitively easy, which, to many would be almost impracticable, or at least, carried on at so great an expence, as to counterbalance the advantages to be derived from it. He might, even in such cases as we are now treating of, erect stages or platforms so contrived, as to carry on the work at all times of the tide, which would be a prodigious saving: for it is a tedious as well as an expensive

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thing, the delays occasioned by the tide in works of this nature; and waggons might be so constructed as to carry, on these platforms, large quantities of materials at once, to be easily emptied, and as easily filled; and they may be drawn by machinery in such a way as to save a great deal of expence in carriage, as well as in the tide work; but I shall treat more particularly of these in another place,* as also on the whole manner of constructing embankments in Holland, where these kind of works have been so very successfully planned and executed.

The next and last species of sea embankment, mentioned above, is perhaps the most important of any; for there are few estuaries, or mouths of rivers, where large and valuable tracts of land may not be gained by embanking. The shoals, or flats, formed at the entrance of such rivers, are often composed of the richest manures, or most fertilizing particles brought down by the stream from the towns above, or from the adjacent country through which the river flows. These shoals may therefore, by proper management, be in general very easily converted into the most fertile plains.

Where such a situation happens, the first object is to collect the whole river into one stream, and to prevent its overspreading a wider extent than just sufficient for its discharge; or, perhaps, it may be better to alter the course of the river altogether, and to make it discharge itself at some other place.

In this latter way, it has been proposed to reclaim that extensive tract called Lancaster and Milthorp Sands, and also Ulverstone and Duddon Sands, and the principle upon which that idea is founded is this: It has been observed and proved by experience, that if the course of a river, or stream, is altered in such a manner as to make it discharge itself into the sea at a different place than it did before, the former place will, in a few years, by the constant accumulation of sand or mud brought in every tide, be so choked up or raised above its former level, as to form of itself, in process of time, a bank that, with a very little assistance, will quite exclude the sea; for as the current of the river before carried away all that sediment which the motion of the waves naturally stirred up, the current being removed, it stands to reason that all, or most of the muddiness will not only be carried farther up the old channel of the river, but a great part of it will be deposited there, as the tide recedes. It has even been observed that in spring tides and particular winds this sediment is deposited in greater quantities than at other times; and I have been informed that a gentleman in Lancashire, who has

* See Practical Treatise on Rural Improvements.

gained some land in this manner, has found, on making a perpendicular cut in the land so gained, that the different *strata* or layers were so distinct, he could easily distinguish those made at spring tides from the rest. This is a very curious fact, and well worth the attention of all who have lands situated at the mouths of rivers, as there may, in many such places, be considerable tracts gained in this manner at a very small expence.

Although this fact may be proved by experience in some places, nevertheless I should imagine the effect would not be the same in all situations.

Where there is a great extent of flat or muddy shores, the motion of the waves will no doubt stir up the mud or sand, and carry great quantities of them along with the current on the flowing of the tide; and when the tide ebbs, although some of the lighter particles will be carried away again, yet it is natural to suppose the heavier ones will be left behind. If the shores are bold and rocky, except just near the entrance of the river, there will be the less of this mud; but, indeed, on such shores there can be little or no occasion for embanking, unless perhaps in some creeks, narrow at the entrance and spreading wide above. From such creeks, if the sea were excluded, a great deal of land might probably be gained.

A survey having been made of Lancaster Sands, and of the proposed alteration of the course of the River Kent, it was found that the length of the cut necessary to be made, from a little way below Dalham Tower to the River Loyne, is 21,340 yards, or 12 miles and 1 furlong. This cut is proposed to be about 34 yards wide, and 4 yards of average depth, making an excavation of 2,902,240 cubic yards; the expence of excavating which, at $4\frac{1}{2}d.$ per yard, would amount to £54, 417. Perhaps this estimate is rather under rated at $4\frac{1}{2}d.$ per cubic yard; but on the other hand, the average depth of the excavation, I presume, is considerably over rated at 4 yards, as a great parth of the depth necessary may be made up by the soil thrown out; consequently, whatever is made up cannot be considered as a part of the excavation; besides, if the River Kent, Lindale Pool, and the other streams proposed to be taken into this new cut, require, when united, a space or channel to contain them, whose transverse section is 136 yards supercial, it would be much less expensive, I should suppose, to add 11 yards to the breadth, and to take one from the depth proposed, unless it is necessary, from the level of the bottom of the river, to make the bottom of the new cut of a certain stated depth.

The whole expence of completing this great undertaking has been estimated at

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only £ 150,000. and in the opinion of some gentlemen 50 or perhaps £ 60,000. less might do. In this estimate I apprehend there has been no allowance made for the buildings necessary on so extensive a tract, nor for inclosing and draining, all which, as well as the interest of money laid out before any return can be expected, should be considered in estimating the expence of improving and bringing into a state of cultivation a barren waste of this nature. Moreover, it is natural to suppose, that in a space of near 60 square miles in extent, if it were ever brought to that highly improved state, to which many people think it capable of; there must of course be a considerable number of inhabitants upon it to cultivate the ground, and to colonize this new acquired territory. In that case there must be places of religious worship, consequently, even the building of churches should be taken into consideration in a general estimate of this kind; besides, in the estimates I have seen, it is taken for granted, if the fresh water is conducted another way as proposed, that in a very few years the sea will completely exclude itself from this extensive tract, and therefore no allowance whatever is made for any sort of embankment across those sands.

I confess I have not yet had sufficient experience in this mode of gaining land, or, as it is called "recovering it from the dominion of Neptune," to put that implicit confidence in it, which many very intelligent and sensible men seem to do; and I should conceive it a very hazardous speculation to lay out so large a sum of money, merely on the faith of Neptune excluding himself, by performing the principal part. If this could be depended on, the speculation would be admirable, and the advantages and profits arising from so great an aquisition would be immense; but if after laying out perhaps near £ 200,000. in altering the course of the rivers, &c. it was found the sea left little or nothing behind, or if it did at one time, that it carried it all away at another, in what predicament must those concerned feel themselves? They must either lose the whole money laid out, or they must expend at least £ 200,000. more, perhaps, in performing what they had trusted so implicitly to Neptune to do. If it were certain that even a fiftieth part of an inch was deposited every tide, the success of the undertaking would be unquestionable, and a concern in it highly profitable; for in very little more than eight years, ten feet of perpendicular height would be raised, and it would be an easy matter to accomplish the rest.

The Duddon Sands are another tract where great improvements might also be made, and at a very easy rate too, when compared with that we have just now mentioned. In their present state a great deal of land, that might produce the best crops, is

frequently overflown, and rendered so wet and marshy, that it is of little or no value whatever. By altering the course of the river Duddon, and bringing it farther north on the low marshy ground, it appears to me, so far as I can judge without actually taking the levels, that, not only the whole of that ground might be completely drained, but a considerable tract of sands reclaimed.

The making of the new channel for the river seems perfectly practicable and easy, the ground being nearly level (excepting a small rise at one place) the whole way from where the new cut would begin, about 200 yards above Duddon bridge, to Haverig pool, where it would empty itself into the sea. The length of this cut would be about six miles, which ought to be made navigable the whole way, with a lock near the sea, and a bason with proper landing places for delivering goods.

The quantity of ground that might be gained, including the sands and marshy ground on each side, would, in Major Gilpin's opinion be about 9000 acres, and the whole expence under £20,000. The quality too of this land has every appearance of becoming extremely fertile; as a proof of which, a farmer who some years ago gained a few acres of it, by embanking out the sea, has found that it produces the best crops of all kinds, even with little or no manure.

So large a tract of valuable land to be gained at so very trifling an expence, is an object highly worthy of attention, not only as a profitable concern, but on account of many other advantages that would arise from it. It is therefore surprising to me that the neighbouring proprietors, or some enterprising private individuals, have not long ago taken the necessary steps to reclaim those sands.

The execution of these projects would be attended with the most beneficial effects to a very large tract of country, and ultimately would be felt in some degree by the nation at large. There would not only be an addition of territory, larger than either of the islands of Guernsey or Jersey, but it would tend to improve at least four times that extent of the interior country. A safe and speedy communication would be opened between the towns of Lancaster, Whitehaven, Ulverstone, Ravenglass, Dalton, Bootle, Egremont, &c. and all the intermediate country, instead of a mountainous and very circuitous route, or a precarious and dangerous passage over Lancaster Sands, in crossing which many unfortunate people annually lose their lives.

Independent of the advantages arising from the produce of the land to be acquired, the produce of the interior part of the country, which, in many places, is extremely fertile, and well cultivated, would be easily brought to market; whereas, at present, it

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is with the utmost difficulty and inconvenience that any commodity whatever can be transported over those dangerous sands, and almost inaccessible mountains.

By diverting the river Duddon into the navigable cut proposed, it would yield the most important advantages to the town of Broughton and all the back country, by facilitating the importation of coal, lime, and other foreign produce of every kind, and the exportation of slate, iron, and other productions of the country; a considerable trade being even at present carried on in slate and iron, which would undoubtedly be greatly increased by carying these projects into execution.

Although several public spirited individuals have taken great pains to forward these truly laudable and important undertakings; yet the opposition, I am informed, that has been given by the proprietors of some trifling fisheries, (who were offered a full indemnification) and from some lords of manors, who would neither contribute towards these improvements, nor relinquish any part of their claims to the ground when improved, has occasioned so many difficulties, that the matter has been for some time in a great measure dropped. It is hoped, however, that in these enlightened times, when the spirit for improvements of every kind seems to be aroused, these very important projects will be again seriously taken into consideration, and that every obstacle towards their completion will be removed. And if the idea of reclaiming Lancaster Sands should be considered as too expensive, and too mighty an undertaking to begin with, an experiment might be made on Duddon Sands, where the money proposed to be expended is comparatively trifling, and where, if the scheme succeeded, there could not be the smallest reason to doubt of success in the other.

SECTION III.

Embanking against Rivers.

Embankments against rivers may be divided into two sorts, namely, for preventing their encroaching on the adjacent lands, and for protecting those lands, and the neighbouring level country from being overflown when the water rises above its ordinary level.

It will be observed, that where the course of a river is a straight line, or nearly so, it hardly ever makes any encroachment upon its banks, unless, perhaps in very large

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rivers, when they rise above their common level, either owing to an increase in the waters, or to their being in some degree affected by the tides. In either case, the waves occasioned by a strong wind, where the river is wide, will moulder away the banks on that side upon which it blows, unless prevented in proper time. This may be done either by securing the bank properly with stones, or by driving a row of long piles pretty close together, at a little distance from the shore; the piles being of such a length and so driven, that their tops may be always above the highest rise of the water. It is surprising the effect that piles driven in this manner have, in resisting the power of waves. Some years ago, when I was on duty as an engineer at a fort near Portsmouth, built on a point of land much exposed to the sea, the waves made such havock, that the walls on that side were constantly giving way, although built in the most substantial manner, and having bulwarks of large heavy stone besides, to protect the foundation: however, all would not do, those bulwarks were soon knocked to pieces, and several times the wall itself. At length it was proposed to drive a number of piles about 40 to 50 yards from the fort. Those piles were 12 or 15 inches in diameter, and driven about one diameter from each other, nearly in a straight line parallel to the wall where the waves did so much damage. They were driven into the ground with a pile engine, till perfectly firm; perhaps 8 or 9 feet deep, and about two feet of the top of them left above the level of high water mark.

After this was done, the walls received no further injuiry, the space between the piles and the fort being always perfectly smooth, however tempestuous the waves might be without. The same simple method might sometimes, perhaps, protect the banks of large rivers, if exposed to the waves, when other methods might fail.

But the most common cause of rivers encroaching on their banks, is the resistance occasioned by a sudden bend. In flat countries, apt sometimes to be overflown where there are any such bends or windings in the rivers, it would be of great advantage to straighten the course as much as possible, for as every impediment or obstruction will naturally cause the water to rise higher than it otherwise would do, and as such bends have that effect, consequently in the time of a flood the waters will overflow a greater extent of country, and to a greater depth, than if the river had a free and uninterrupted course straight forward.

If the windings of the river cannot be altered, and that encroachments are making on some part of the banks, it must first be considered whether the force of the water can be diverted to another place, where no injury can be done. If, for example, a

river is encroaching on its banks at A, fig. 2. a jutty of stone a little way up the river, in the direction B C, would throw off the current towards D, and might totally prevent any further encroachment.

On the River Nith in Dumfrieshire, a good deal has been done in this way by Mr. Millar of Dalswinton, a gentleman of the most enterprising genius, and most liberal mind, who has paid more attention, and laid out more money in making important and useful experiments, than almost any other private individual. The course of the river, where Mr. Millar has been carrying on his operation, is nearly as follows: A E B C, fig. 3. is the river, at B it was encroaching most rapidly, and seemed inclined to take a new course towards F, which would have destroyed some very fine land, and done a great deal of mischief in that part of the country. To prevent this, Mr. Millar made a large cut about 400 yards in length from D to A, and threw in a great quantity of stones quite across the river at E, to direct its course in a straight line from A to D. This had in a great measure the desired effect, by totally preventing its progress at B, but now it began to encroach on its banks at C. He at first endeavoured to prevent this, by driving in, at a considerable expence, a number of piles at a little distance from the bank, and wattled them with willows, branches, &c. thinking thereby to protect the bank. The piles were drove in with heavy mallets, apparently firm into the ground; they continued so for some months, till a heavy fall of rain came on, which swelled the river, undermined the piles, and carried them all away. But indeed it is in vain to think of piles doing any good in such a situation, unless firmly driven in by a pile engine, for it is not possible to drive them in properly with mallets. This must have been the cause of their giving way so very soon.

The piles not succeeding, Mr. Millar was resolved to try another plan. Several of his adjacent fields being covered with an immense quatity of stones, he ordered them to be gathered and thrown into the river, so as to form a jutty at G, a little way above the injured bank. Being obliged to go from home about that time, and to leave the execution of the work to some country people, they carried out this jutty too much at right angles to the stream. It had not therefore the desired effect, but rather made the matter worse than before; for if a jutty is carried out at right angles as at B, fig. 4. the current will be forced from B, to the opposite side of the river at C, and from thence it will rebound towards D, more violent than it did before. But if a jutty is placed obliquely as at E, it will force the current gradually towards F, in which position one jutty may do more good than several placed improperly at right angles.

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Mr. Millar was therefore under the necessity of making other jutties in this way, and has now the satisfaction to find that they answer the purpose intended. Those he made laterally formed a sort of convex slope, the convexity being parallel to the current. Strong planks were also firmly set on edge among the stones, their ends pointing towards the river; so that if ever any current came so rapid as to move any of the stones, it must move them all in a body the whole length of the plank.

Perhaps this precaution was unnecessary, for although stones are thrown into a river loose in this manner, the slush, sand, &c. that come down the river, will soon fill up all the cavities, and render it as firm and solid as a regular built wall.

I have been the more particular in this description, to shew the errors that Mr. Millar at first fell into, and the great expence they occasioned; whereas, had he been on the spot himself, and got the work executed as he intended, it would have saved him a great deal of money.

The next sort of embankments against rivers, are those to prevent them overflowing their banks, and inundating large tracts of country. This may be considered as the simplest and easiest of all sorts of embanking, if judiciously executed. It is therefore the more inexcusable to see in some places extensive tracts of the richest meadows completely overflown by every flood.

Few ordinary sized rivers rise more, even in the greatest floods, than five or six feet above their common level, unless when they meet with some considerable interruption, or confinement in their course. But if interrupted or confined, they will rise perhaps twenty feet or more, as is the case with some parts of the River Mersey, already mentioned.

If, for example, a given quantity of water is six feet deep when running over a space 20 feet wide, it is clear if that space was made only 10 feet wide, the water would rise to 12 feet, and if it were made 40 feet wide, the same quantity of water would rise only to the height of three feet.

It is therefore of great consequence in preventing inundations, to give the river as much width as possible, by widening every narrow place. All kinds of obstructions should also be removed, whether occasioned by windings, shoals, stones, trees, bushes, or any thing else. In some cases this may even preclude the necessity of embanking; but where embanking is necessary, let the banks by all means be at a sufficient distance from each other, to contain with ease between them the largest contents of the river in great floods. The distance and height of the banks may easily be ascertained by

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measuring a section of the river when at its highest, or when the flood mark is visible. By not attending to this, a great deal of money has been thrown away on the embankments on the River Mersey, and after all, they do not effectually answer the intended purpose, a great part of the country being still overflown, every time the river rises to any considerable height.

Where a sufficient distance is allowed between the embankments, their height need not exceed from four to six feet. If irremoveable obstacles are in the way, which cause the river to rise higher, the banks must be higher in proportion. In either case, however, the slope of these kinds of banks on each side may be equal to its perpendicular height, and the breadth on top about one third of that height: which, supposing the bank 6 feet high, the base would be 14 feet, and the breadth of the top two feet, as shown in fig. 5.

The materials for making these banks should be taken as much as possible from the sides of the river, which will have the double effect of widening the river and forming the embankments, and there should be a trench on the inside, (from which materials will also be got) with some sluices, as formerly directed, to drain off any water from within, also sluices to let in water from the river, if required, which would very much fertilize the meadows, if properly laid out for that purpose.

SECTION IV.

Embanking against Lakes.

The last sort of embanking we shall mention, is against lakes, or loughs, as they are called in Ireland and Scotland, and meres in the North of England.

It generally happens that the waters in those lakes subside greatly in the summer season, and that they rise considerably in winter, or when the season is wet.

In some lakes, the extent of surface overflown in winter so far exceeds what the water covers in summer, that it would be a great object, and in some cases a very valuable acquisition, to confine the lake within its summer limits, or at least to cut off some of its branches or creeks.

If either of these is to be attempted, the principal outlet must first be examined, and that should be enlarged and widened considerably, which, upon the same principle as

already mentioned respecting the widening of rivers, will prevent the water rising so high as formerly. If the levels will not admit of much depth being got, or if the ground is rocky, and would be difficult and expensive to deepen, let the breadth be increased as much as possible, and every obstacle cleared away, that the water may run freely in a shallow stream. If it is required to ascertain exactly, or to fix the future limits of the water, a section of the greatest quantity running out during a flood should be taken. Suppose this section, for example, is 10 feet wide and 4 feet deep; by making it 40 feet wide, the same quantity of water will not rise above one foot, consequently, by this means alone, three feet in height will be gained all around the lake, which, in case of embanking it, would be a very great object.

The summer season, when the water is lowest, is the best time to carry on these as well as other embankments. If, however, any materials are to be brought from a distance, they may be laid down, or prepared at other seasons, excepting turf, which ought always to be used as soon as possible after it is cut.

The manner of constructing embankments of this nature will be sufficiently understood from what is already said on the other sorts of embankments, observing as a general rule, that where the materials on the spot will answer the purpose, they ought invariably to be used, although at the expence of digging a trench larger and deeper than would otherwise be necessary. It must also be observed that in executing all sorts of embankments, the greatest care should be taken to make them perfectly firm and water tight, by constantly beating and ramming them well, during the whole time of erecting them.

Besides the various kinds of embankments here mentioned, there is still another kind, which requires a different mode of management. Embankments on the sides of canals, and for the purpose of raising those canals to their proper level over hollow places; but as these are of so different a nature from the subjects herein contained, and as they are fully discussed in the work already referred to,* it is unnecessary here to enlarge upon them, I shall therefore now conclude, having purposely omitted entering more minutely into a detail of the practical part, which would have led to a discussion not at all requisite in these general observations. I have, however, to regret, that it has not been in my power to enlarge so fully as I could have wished, in my remarks on embankment, already executed, having not yet had an opportunity of examining many

* Pratical Treatise on Rural Improvements.

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very important embankments in various parts of the kingdom, particularly in Lincolnshire, Cambridgeshire, Yorkshire, and some other places, all which, as also the embankments in Holland, should be very minutely investigated, and the manner of their construction, as well as their good properties and defects pointed out, in order to render a work of this nature so complete as it ought to be; but if, by endeavouring to show the facility in most cases, and the beneficial consequences of reclaiming land by embanking, these few observations should induce any attempts to be made in that way, they will, I presume, so far at least answer the purpose for which they are intended: at the same time, if I have not been sufficiently explicit on these, or on any of the other subjects which I have had the honour of submitting to the Board of Agriculture, I shall with pleasure, if required, afford any additional information, or give any assistance in my power, towards promoting the patriotic views of that honourable Board.

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XIV.

Essay on the various Modes of bringing Land into a State fit for Cultivation, and improving its natural Productions. By James Headrick.

The general object of this eassy is to point out the physical obstacles which impede the cultivation of land, the means of removing these obstacles, and the various methods by which the land may be brought from a state of waste, into a state of fertility and production.

In the progress of this paper, soils of every kind will of course be considered, the mode of improvement that is adapted to their elimature, local situation, and the objects to which the land is to be applied. A few experiments, with a view to detect the cause of sterility, and consequently the means of giving fertility to soils, will be enumerated, and the most successful methods of bringing peat bogs into a state of cultivation will be pointed out.

Where the Author has occasion to borrow from the writings, or from communications of others, he is always anxious to acknowledge the obligation: but a great part of this essay is the result of his own observation, though several of the methods described are not his own invention. He will be careful to ascribe every thing new to its proper author.

SECTION I.

The chief impediments to the cultivation of land are, 1st. stones; 2d. wood; 3d. broom, whins, furze, and brushwood; 4. heath; and 5. a rough and sterile surface.

It might have been added that water, either stagnant on the land, or issuing from subterraneous springs, is an effectual impediment to the cultivation, or melioration of land, and must be removed before any improvement can be made. But the various modes of draining land, and the circumstances in which each mode is applicable, do not fall under our deparment of this work; these have been ably treated of by different writers, particularly by Dr. Anderson in his *Essays relative to Agriculture and rural Affairs.* In a late publication, Mr. Johnson brings into one view all the various

modes of draining land, and points out the situations in which each mode is successful, to which the reader is referred. Nor do we mean to treat of the improvement of land, by banking out the overflowings of rivers, or by excluding the sea from those parts which are occasionally overflowed by the tide, means by which immense tracts of productive surface might be added to the Island. The mode of improvement, by bringing water over the surface of land, that is previously laid dry, is also left to abler pens. These things may come to be mentioned incidentally, though they do not fall under the design of this essay.

1. *Of Stones.*—The stones which impede the improvement of land, and which require to be removed, before it can be rendered productive, are of two kinds: 1st. loose stones, or such as are thrown up to the surface by the plough; 2d. *sit-fast* stones, which are either concealed under the surface, or are of such magnitude that they cannot be stirred by the plough.

All stones found in cultivable soils exhibit evident marks of having been worn and rounded by water. Indeed the soils themselves are chiefly composed either of the decayed particles of the rocks, or of indurated *schistus*, on which they rest; or, they are composed of the particles of other rocks, mixed with vegetable substances, which have been conveyed into their present situations by torrents. The stones found in these soils are either the remains of former rocks, which existed in these places, though they are now washed away, or they have been conveyed from still higher rocks by the impetuosity of torrents. In either case, their having been rounded by water is accounted for.

Where there are no concealed, or fast stones in land, and this is generally the case in all washed, or loamy soils, those that are thrown to the surface by ploughing and harrowing may be easily gathered and carried off. It is common, in most places, to gather all the loose stones that appear when the land is thrown down in grass, that they may not interrupt the scythe; but they are often thrown in heaps into the furrows, where they ever after continue to interrupt the plough, or are dragged again by the harrows, and scattered over the land. These stones are of considerable value to the farmer, for the purpose of making concealed drains, or for making and repairing the roads through his farm. The gateway into every inclosure should be well laid with stone, as this is the spot where cartage is most frequent: without this precaution it

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often becomes a mire, where corn is thrown down and spoiled in harvest; or, by attempting to avoid the mire, the gate posts and fences are often demolished.

When the land is too wet, at the time of gathering the small stones, to admit cartage, they may be laid in heaps, and afterwards removed when it becomes dry; but in general, the best time for removing stones of every kind is during a course of fallow: a few single horse carts, with a boy or two to lead, and a man to empty them, and a sufficient number of women and children to gather and throw the stones into the cart, will soon clear a vast extent of such stones as can be lifted by the hand. This operation should be repeated every time the land is ploughed and harrowed, until no more stones appear. There is a peculiar propriety in removing stones during summer fallow; because, at this time, they can be removed effectually, and if concealed drains be necessary, the stones of the field may serve to construct them, and save the expence of distant cartage. If, after all, new stones are thrown up in the course of cropping, they should be removed as they appear; and the land should be effectually cleared after grass seeds are sown before they are rolled in. Some rollers have a hopper for receiving such stones as may appear when grass seeds are rolled in.

I never heard of any but one exception, to the propriety of clearing land of small stones, and, I think, it is mentioned by Lord Kaims. In some parts of Galloway, and the south-west of Scotland, the soil is said to be composed almost wholly of gravel. and of water-worn stones, which have been thrown to the surface by the plough. The superficial stones prevent the exhalation of moisture from below, at the same time that they imbibe heat above from the solar rays; of consequence the crop pushes its roots below, and all around the upper stones, where it finds moisture, while its tender blade is made to vegetate rapidly by the heat reflected from the stones. Some farmers who had removed the upper stones, found their crop was wholly blighted and withered in the tender blade, partly by the sun's rays, partly by the exhalation of moisture occasioned by the winds, and it never arrived at maturity. From this circumstance they were induced carefully to replace the stones which they had formerly removed; but instead of replacing their stones, I would have advised them to cover the whole surface of their land by a thick coat of clay marl; good earth, or loamy clay, would have been next in point of efficacy; or they might have applied a compost of bog earth and lime, of moss and lime, or of earth and lime.

Where stones are large, or are set fast in the earth, all those which appear above the surface ought to be removed before the ploughing of the waste wherein they are found, is attempted.

With respect to those which are concealed under the surface, various methods have been adopted. I am told that the people in Yorkshire go over the whole surface of the land, which they wish to improve, with sharp prongs; these, they thrust down to the depth of above a foot, at the superficial distance of from 12 to 14 inches, and wherever a stone meets the prong, a mark is placed. The mark is a twig, spar of wood, or any thing that can render the spot visible. They afterwards trace all the marks, and grub up every stone, before they put a plough into the land.

In other places the ploughman carries a number of twigs, spars, &c. in the hollow of his plough, and wherever a stone occurs which he is unable to throw out by the plough, he plants his twig as a direction where to find the stone. I have known ploughmen, with a pair of well trained horses, throw stones of very considerable size up to the surface, in the course of a few minutes, while they seldom or never broke their ploughs. This suggests an idea that it would be easy to contrive a machine, by the aid of which, horses or oxen, might speedily throw out the largest stones that are concealed under the surface of land.

But where a field is excessively overrun with concealed stones, I am convinced that the cheapest and most effectual method is to delve or trench it wholly by the spade. The trenching can be done for 3 to £4. per Scotch acre; and, in addition, it is common to allow the quarrying price for every cart load of stones that is turned out. Beside most effectually clearing the stones, trenching deepens the soil, and enables the improver to lay it in a most convenient form for cultivation. I have heard of a certain bigotted admirer of the ancients, who was wont to date the decay of agriculture from the invention of the plough. Though his opinion was extravagant, yet agriculture would certainly receive much improvement from a more frequent use of the spade. From Dr. Anderson's very excellent Report of Aberdeenshire, we learn that more is done in this way, than perhaps in any other district of the Island. The expence of trenching an acre to the depth of, from 12 to 14 inches (Report, p. 74.) "where the stones are not very large and numerous, runs from fourpence to sixpence a fall, which is from fifty three shilling to four pounds per Scotch acre. Ground that has been formerly trenched is sometimes done as low as two-pence per fall, or twenty-six shillings and six-pence per acre." From this it would appear, that the ground is not only trenched

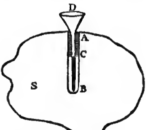
at first, but the stones also taken out at a lower expence, than we have stated. But this only shews that, wherever a practice becomes general, workmen become expert, and reduce the price by their mutual competition: we have stated the average expence of trenching an acre of land, in situations where this beneficial practice is unknown, or seldom attempted.

With a view to get rid of large stones, some dig a deep hole beside them, into which a stone is tumbled, and buried to the depth of more than a foot below the surface. Before the hole is dug, it is necessary first to ascertain the dimensions of the stone, for I have sometimes seen it necessary to dig another hole after a stone had been thrown into a hole too small, for its reception. When the hole is so far advanced, that the workmen can get under a corner or edge of the stone, they should lay a plank across to support it, as dangerous accidents have occured from heavy stones falling upon the men while employed in digging the hole.

But where stones are wanted for fences, or other buildings, it is necessary to blast those that are not of a portable size. To perform this properly, some experience is necessary, and a skilful workman can rend stones generally into three equal pieces without causing their fragments to fly about. This depends upon the depth and position of the bore. It is said that a small portion of quicklime in fine powder diminishes the expence of gunpowder in blasting stones.*

* As gunpowder is now become very costly, the expence of blasting is much enhanced, and various substitutes have been proposed.

The following is submitted to the consideration of those who may have opportunties of trying such experiments; at the same time as I never had experience of its effects, I cannot be positive respecting its success.



S, is a large stone, to be blasted, or rent. A B, a bore sent down into it, in the usual manner. This bore, being previously well cleaned and dried, is filled from B to C, with the purest quick lime,

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But there are a vast variety of stones which can be broken and removed without having recourse to blasting; such stones have generally some thin veins, which, being found, can be penetrated by wedges; or by laying them upon props, they may be broken by sledge hammers. In performing these operations, the instruments necessary are spades, pickaxes, to clear away the earth, a large and a small iron crow or lever, and a long and powerful wooden lever, shod with iron, to turn them out of the ground; a sledge hammer is also necessary, and a smaller one with a long handle. When the stones are reduced to the size wanted, they are conveyed from the field by carts: some use slipes for this purpose, which, though they require more power to draw, do not occasion much labour in lifting the stones into them. Others again have frames of wood constructed for taking stones off their land, which run upon low broad wheels, of rollers. In some cases I have seen large hand barrows used for conveying heavy stones, with as many handles, all round, as would enable a dozen or two of men to join in the work; and the stone was carried after the manner of a corpse. But such an instrument is chiefly useful in conveying large stones to prop up a mill dam, where horses cannot walk.

or such as swells most in slaking. That it may be perfectly quick, it should be taken red hot from the kiln, or from a small furnace where it is burnt until it no longer effervesces with an acid: being rammed hard with the jumper, or punch.

A C, the upper part of the bore, is crammed with rotten rock, in the usual manner.

The pricker being removed, which leaves the aperture terminating at B,

D B, a small pipe of copper, of less diameter than the needle, or pricker, and having an orifice about the dimension of the straw used to convey the fire down to the gunpowder, with a funnel at D to receive water, is introduced into the aperture. Perhaps a straw stuck in the lower part of the funnel, among tallow or bees wax, might serve the purpose of a copper pipe.

Things being thus prepared, pour water into the funnel at D, and if the pipe be not too tight so as to prevent the air from escaping from the aperture left by the pricker, it will descend, and cause the lime to slake in the bore C B.

Every one knows how irresitibly the purest quicklime attracts water, and with that prodigious force it expands, in slaking, into 3 or 4 times its former bulk. From these acknowledge data, I infer that the slaking of lime, in such circumstances, would burst, or rend, the stone S in pieces; but the success of such an experiment must depend entirely upon using lime of the utmost purity, and having it very hot, and perfectly caustic, when it is put in.

Were the bore C B filled with water, and the aperture afterwards rammed up, the water being made to freeze by cold, would rend the stone; for when water passes from a fluid to a solid form, it expands with irresistible force, though frost cannot be much depended upon in this climate.

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In the statistical account of Scotland, Vol. XIX. p. 565. parish of Maderty, we are told that, " the Reverend Mr. Ramsay, the present incumbent, who occupies a piece of land full of *sit-fast stones*, constructed a machine for the purpose of raising them. It operates on the principles of the pully and cylinder, or wheel and axis, and has a power as 1 to 24: it is extremely simple, being a triangle, on two sides of which the cylinder is fixed; it can be easily wrought, and carried from place to place by 3 men. A low four wheeled machine, of a strong construction, is made to go under the arms of the triangle to receive the stone when raised up. This machine has been already of great use in clearing several fields of large stones in this place and neighbourhood."

It is obvious that though such a machine may be of great use in raising large masses of stone, yet that such masses so raised, and carried off the field, can be of no use, except for propping mill dams. It is elsewhere stated in that account, that fences are almost unknown in the parish of Maderty: it appears therefore, that it would be more advantageous to blast the stones, and then each fragment would easily be reduced to such a size that it could be lifted with the hand. Thus the stones might be employed to construct fences, where their value would more than compensate the expence of removing them

It frequently happens that particular spots are filled very thick with stones, laid in regular strata, and not so much water-worn as land stones commonly are. These are the fragments of some stratum of rock, which had decayed by the weather, or had been demolished by the rushing of torrents. When limestones are found in this manner, they should be carefully traced, as they commonly conduct to some stratum of lime rock at no very remote distance: there are, however, water-worn limestones scattered here and there through land, called stammerers; which, though they have also been detatched from the out-crop of some lime stone rock, have been conveyed from a considerable distance, and afford no certain indication of the bed from which they came.

It is of great importance to have land effectually cleared of stones, for there is frequently more expence incurred in one season by the breaking of ploughs, and injury to cattle and harness, by working of stoney land, than would remove the evil. It has also been observed, that the soil around stones is commonly the best in the field. When stones occupy the surface, it is so much land lost; when they are below, but within reach of the plough, the ground around them, for a considerable space, cannot be stirred, and is therefore useless. Removing the stones, therefore, is like purchasing an additional quantity of land at perhaps so low a rate as one years purchase, while the part

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that was free of stones, is rendered capable of being wrought with much greater rapidity and cheapness

2. *Of Wood.*—Where it is necessary to clear land of wood, with a view to its cultivation, various methods have been adopted.

In America they judge of the value of land, 1st. from the species; 2d. from the size of the trees which grow upon it. Large oaks are always preferred, because the oak never attains an immense size, except upon a strong and deep soil; the wood is also more valuable on being removed: large trees of any kind never have brush or underwood beneath them, and they stand at a considerable distance from each other.

They begin with ringing the trees, that is, cutting a ring of bark from their stems a little above the ground. This checks their growth, and renders the wood more firm and valuable after they are cut down: this is generally done a year or two before they begin to fell the wood.

When the trees are felled, if they be within the reach of water carriage, they are formed into logs, planks, staves, shingles, and the various articles with which they supply the West Indian markets. The branches are burnt upon the ground, and the ashes partly manufactured into pot-ash, partly scattered over the surface, to excite the fertility of the soil. It is understood that the value of the wood commonly repays the expence of clearing it: the stocks and roots are allowed to remain in the ground, but in that climate they very speedily rot, and soon occasion no interruption to the plough. I conceive it would be better to cut the trees at such a depth below the ground that the plough could never reach the stocks, and then fill up the holes with earth; but in America, the saving of a little surface of land, even though that saving should render the remainder easier cultivated, is seldom attended to.

Meanwhile the interstices between the stocks receive a slight scratching with a miserable plough, and are sown with such grain as they are thought best adapted for. The produce is generally very considerable during a number of years; for the leaves of trees which had fallen for ages, and which speedily rot in that country, have left a sort of natural manure to fertilize the soil. Of this manure they make a very bad use; for the same crop is often continued 20, 30, 40, or 50 years upon the same land, without interruption, or any new addition of manure, until it no longer carries the seed.

These operations are generally carried on by a class of men who have no other capital, but their labour and their tools. They may be considered as the pioneers of Agriculture, who advance in the van to demolish those trees which oppose its progress.

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But it is a pity that while they remove obstructions, they should be permitted to waste and exhaust the natural fertility of the earth: a piece of land, scalped and mangled in this way, will afterwards require more expence to put it into a productive state, than would have been necessary to clear it from wood. This is ultimately done by men of capital, who purchase tracts of cleared land, and cultivate them upon a more rational system. The pioneers find it more their interest to advance upon new land, than to presevere in the cultivation of what is already cleared.

We may here advert to a delusive dream of the celebrated Abbé Raynal. Having learnt that the cultivated lands in America were perpetually becoming less productive, he pronounced the productive powers of that continent to be very limited, and his imagination seems terrified at the prospect of its becoming a dreary waste, incapable of affording sustenance to man or beast; as if the laws of nature imposed upon that portion of the globe were totally different from those, we see operating every where else!

The true cause seems to be as we have stated. Though agriculture be almost the only art known in America, yet it is in a very imperfect state: they know nothing of a proper rotation of crops, for preserving and prolonging the fertility of the earth; of alternate cropping and pasture; of fallows, or cleaning crops; they are at no pains to collect or accumulate manures, and their instruments, except those brought from Europe, are extremely awkward and inefficient. It is probable this state of agriculture will continue until, the country being generally stocked with inhabitants, land becomes much more valuable than at present. The introduction of African slaves into the southern states has thrown a powerful obstacle in the way of their improvement. The labour of slaves is the dearest of any, because it is paid per advance, whereas free labour is paid as it is used. I am informed that in the southern states, there are seldom more than a third of the slaves upon an estate fit for duty at a time, yet they must be maintained; and this occasions a vast proportion of land to be constantly planted with Indian corn. It gets little or no manure, and we need not wonder that the land is constantly growing worse, and the crop less valuable. Were any land in Europe thus treated, it would soon be reduced to a *caput mortuum*.

An ingenious American, from whom I learnt some of these particulars, remarked to me one day, "that the people of this country seemed to be amazingly industrious! For," added he, "all the parts of this island I have yet visited are almost entirely cleared. A few patches of trees, and some stragglers, still remain in different places; but if

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they persevere a little longer, they will soon get the better of them."—I learnt that it was common in America to pronounce the people of a district *very industrious*, where there was a considerable extent of cleared land: and this gentleman, at his first arrival in Europe, was apt to apply his American ideas to every thing he saw. He was not aware that the proof of industry here, is not the *demolition*, but the *rearing* of trees.

It would certainly be the interest of the British proprietors still farther to increase the amount of their woodlands and plantations. There are many tracts of waste land which would be better occupied by trees, than by any other mode: in many places, trees are wanted for shelter, in others for ornament.

But there are many useless patches of trees and shrubs interposed among the cultivated land, which it would be proper to grub up. Often do we see a swaggle with a few miserable allers, or dwarf willows, lying in the midst of good land, which it disfigures and annoys. If stones be not at hand, the brushwood of such a place might be used to fill the concealed drains, and what is now a blemish, be converted into the best land in the field.

Some trees send their roots deep into the earth, and to be rid of such, it is only necessary to dig to the bottom of their stocks, cut a few of their lateral roots, and pull them down with a rope. Others extend their roots a little below the surface, and such roots must be removed before the plough can pass through the land. There is no mode so effectual in such cases as trenching with the spade, and tearing out the roots with a pickaxe; by this, the roots are not only completely extracted, but the land may be laid into a convenient form. The roots and brushwood being burnt, and the ashes spread, the produce will more than repay the additional expence of trenching.

3. *Broom, Whins, Furze,* and *Shrubs.*—The broom generally prefers a dry, gravelly, or sandy soil. The whin (furze) thrives best on a strong soil approaching to clay, but which is at the same time dry. The bramble delights to grow and spread itself in such soils as are adapted for the broom. The black thorn and hawthorn commonly occupy those places where stones, or points of rocks, guard their dominions from being assailed by the plough: there their seeds, voided by birds, take root among the land stones and weeds, commonly thrown into such places, and when they attain maturity they are perpetually extending the bounds of their empire by suckers, or by dropping new seeds; but a sheltered bank, of a strong rich soil, is the situation where

thorns attain the greatest perfection. The dwarf willow always thrives best on a damp moist soil. About other shrubs it is unnecessary to be more particular.

Land that is overrun with these shrubs may be either planted, or reduced into a state of cultivation.

For planting, shrubby ground is well adapted, because the shrubs nurse and shelter the young trees during infancy, and are themselves at last extirpated by the trees, after their branches begin to overshadow the ground.

Among broom, the larix, and the various species of pines, thrive best, from the quality of the soil. The soil best adapted for whins is also well adapted for the oak. The trees most proper to be planted among other shrubs, must be judged of, from the quality of the soil in which they grow.

Some plant trees among the shrubs we have mentioned without cutting them down, or after cutting out holes among the bushes for their reception. I have seen an oak that had been planted in the heart of a whin bush contend long to overtop its nursing parent, and having at last prevailed, proceed to smother the benefactor of its infancy. But it frequently happens, that young trees, planted among thick bushes, are smothered before they get above them; and I should think the better method would be to cut all these shrubs over by the ground, and even to root them out in those spots where the trees are to be planted. This would give each young tree a circular space where it could grow without annoyance, while the shoots of the surrounding shrubs would start along with it, and never endanger its being smothered.

But there are vast tracts of shrubby land which it would be more profitable to reduce to cultivation, than to occupy with trees; and for this purpose the shrubs must be previously removed.

When broom and whins have not acquired large stems, or large stocks, in consequence of having been frequently cut over by the ground, they may be cut down by a strong short scythe, or hedge bill, and afterwards rooted out by a strong Scotch plough drawn by 4 or 6 horses. All the roots that can be removed should be gathered, the land again cross-ploughed, gathered as before, and afterwards braked: these operations should be continued until no more roots can be found; for if roots are left in the moist parts of the soil, they soon spring with new ardour, and the land is more infested by them than before. The same observations are applicable to thorns, brambles, and other shrubs of that nature: when all the roots are collected, they should be burnt in

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heaps, along with the shrubs, if not wanted for other purposes, and the ashes equally sprinkled over the ground.

When shrubs of any kind have acquired large stems, or stocks, the common practice is not to cut them down, but to hole them out, with spades and pickaxes, as in the case of trees. When this practice is adopted, it is previously necessary to fire whins, in order to uncover their stems and roots: after the roots are torn out on one side, the stem affords a handle at which one man can pull, while another works below, until they have rooted out the shrub. A strong lever, shod with iron, and having the iron shoeing bent a little upwards by a gentle curve, is a powerful instrument for rooting out shrubs. The iron extremity should divide into two prongs, with an edged angle, similar to a hammer for drawing nails; such an instrument may be thrust in below a shrub of any kind, until it seizes its tap root, and by the aid of a stone, or block of wood, to serve as a fulcrum, the shrub may be rooted out by one effort.

A Scotch acre of whins is worth from £3 to 5. as winter food for horses and cows, to those who have a stone running upon its edge for bruising them, provided the shoots are not older than from 3 to 4 years, and that there are no impediments to interrupt the scythe; hence an inference that, in many cases, whins are the most profitable crop that a soil can bear, provided they be duly managed.

Sheep are excessively fond of whins, and of the tender shoots of broom; they are also very much attached to the shoots which the bramble throws up in spring. But, unfortunately, when a poor animal, in quest of food has thrust its head into a bramble bush, armed wirh spikes and with branches which vegetate every time they touch the ground, it gets entangled by the neck; endeavouring to get free, its whole body gets entangled, and it may perish from want and exertion, before it is missed or relieved.

I cannot speak so particularly about thorns and other shrubs, because I never knew them interposed in sheep pasture, except when they were tall, and the sheep were perpetually entangling themselves among them; but I remarked that detached bushes were so nibbled, that they assumed the form of bee hives, and that where the mouths of sheep could reach the branches of a brake of thorns, it appeared as if clipped with hedge sheers.

Hence I infer that no food is more palatable, or more nutritious to sheep or cattle of any kind, than the tender shoots of shrubs or trees. I have seen cows browse most deliciously upon the tender shoots and flowers of the broom: I have seen them also

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attempt the whin. These plants convey to their milk a peculiar flavour, and to their butter a colour resembling gold, though much more vivid.

But animals with large mouths cannot select; they may gnaw the flowers, and tender shoots of the broom, and suck in the juices which flow through the woody fibres and filaments, which they abhor. When they attack a prickly plant, they are repelled at every point.

The sheep can thrust their snouts into the cavities of a broom, can select the flowers and tender shoots, or when they engage with the whin, can nibble those tender shoots where what is destined to become prickles yet remains soft, and thus prevent the farther extension of the plant.

I knew an extensive range of hilly ground, which was covered here and there with whins, and was an excellent sheep walk. In most places the sheep kept down the whins, they being nibbled all round into the form of beehives; where there was a considerable depth of soil, the whins, in a course of years, generally got the better of the sheep, and covered the ground so as to exclude them from it. When this happened, the whins were commonly burnt, and the sheep admitted to browse upon the tender shoots of the ensuing spring. When the lease expired, the proprietor fenced off, and planted with trees a large tract of this hill; and that the sheep might not destroy his plantations, he took the ensuing tenant bound to dismiss his sheep, and pasture the remainder of the hill with cattle. When I last saw the ground, the whins had spread so enormously as to exclude cattle of every kind from the premises. In some places, where there was a considerable depth of soil, they had become like small trees. Thus a large tract of excellent pasture was rendered totally useless: they could not fire the whins without the most imminent danger of burning houses, and the plantations; and it was universally agreed, that the fee simple of the land would not defray the expence of rooting them out. I presume the proprietor would see the necessity of planting the whole.

From these circumstances I infer, that if whins, or shrubs of any kind, are once grubbed up in the way described, sheep, being admitted to pasture, would prevent them from ever growing again from the small roots left in the ground. But still more would this experiment be likely to prove successful, if the ground were completely fallowed, and every root that appeared, removed. The land, being well limed and manured, might be subjected to a course of cropping, and be sown down with grass seeds without a crop. As soon as the grass afforded a safe bite, I would admit sheep, and not wait

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for a crop of hay: I presume the sheep would destroy the tender shoot of every shrub as fast as it rose, and keep the ground ever after clear.

It has been often found that after much expence in clearing land of shrubs, they get up again an hundred fold, after the land is thrown into pasture: this must be imputed partly to the seeds, and partly to the small roots left in the ground. Pasturing with sheep appears to be the only remedy. If after all, they threaten to get the better of the sheep, they should be ploughed down again, before the roots have acquired strength to resist the plough, and the preceding operations repeated.

There is a peculiarity in whins, that though they delight in a strong, deep, and friable soil, they will not spread upon moss, upon washed loams, or soils that are saturated with animal or vegetable matter, though they be laid sufficiently dry for their reception. Lime they abhor, and an effectual remedy against their resuming possession of a field seems to be working and manuring it sufficiently.

With respect to broom, the best plan seems to be changing the quality of the soil on which they grow; as they prevail chiefly upon gravelly and sandy eminences, which are replete with their seeds as well as roots, a strong dose of clay marl would change the texture of the soil, and render it uninhabitable by them. If marl cannot be got, a compost of moss and lime, or of clay and lime, would answer the same purpose.

In many situations, brushwood and shrubs may be sold at much more than the expence of rooting them out of the land; in all situations they are useful for wattling up paling, or for making dead fences at the back of young hedges.

4. *Heath*—Is a plant of the most hardy nature, and grows only upon the most sterile soils. By sterile, I do not mean soils absolutely incapable of being rendered productive, but such as have received no melioration from working and manures. The natural goodness of a soil may be known from the size and vigour of the heath which grows upon it, just as the Americans judge of the value of land from the size and species of the trees which it carries.

If the land be relieved of its dampness, and the heath burnt upon the surface, it will, in time, be extirpated by sheep. These animals are excessively fond of the tender shoots and flowers of heath, which seem to be medicinal to them, though nothing but extreme hunger can induce them to taste it, after it runs into seed.

Lime is a most mortal enemy to heath, and we shall see that it can easily be extirpated by that weapon. The plant abounds in the gallic acid, and grows only upon

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such soils as are replete with acids: lime by neutralizing these, robs the plant of its natural food.

Long heath makes a most exellent thatch for houses, far more durable than straw of any kind; it also makes excellent rinses fot scrubbing milk vessels. From its extreme durability, it is the best of all shrubs for making concealed drains: where, therefore, it prevails in a field that is about to be reduced into cultivation, it should be cut down as closely to the ground as possible, with a strong short scythe, and applied to any of the purposes mentioned; or it may be burnt early in the spring, as it grows upon the ground, together with all the coarse grasses that are intermixed with it. A strong plough may then be employed to turn over the soil, though it cannot be advantageously ploughed with long heath growing upon it, as this prevents the fur-slices from coming in contact with each other, and thus from retaining moisture to rot the sward. A strong dose of caustic lime, laid upon the surface of the ploughed land, in the course of about 6 months, consumes the roots of heath and coarse grasses, renders the soil friable, and prepares it for a crop. Some lay a dose of lime upon the land before it is ploughed, and another after, that the fur-slices, being wholly surrounded by lime, may the sooner be brought into a friable state. Indeed, economy in the use of this ingredient at the first breaking up of muir land is economy misapplied; but it should be laid on in a finely powdered state, highly caustic, and as equally as possible. For reasons frequently repeated, I am inclined to think that it would be most profitable in the issue, if the expence could be spared, to turn up wild land of every kind, for the first time, hy the spade.

The plants best adapted for wild land of this sort, are such as throw out a luxuriant herbage, and shield the land from the sweeping winds, the sun's rays, and prevent the exhalation of its moisture. If the soil be of a sandy quality, and sufficiently friable, after the lime has remained upon it some months, it may be at once reduced by a spring fallow, sown with turnips, and the crop fed off with sheep: but if the soil be an obdurate clay, and especially if it approaches to a pyritical and aluminous schistus, this cannot be done, and grey oats, rye, buck-wheat, or other hardy grains, are probably the first crop that it can carry. Some sow buck-wheat and other plants upon sterile land, and afterwards plough them down for manure. I conceive this to be a very bad practice, and that it would be better to feed cattle in the house with such crops; or to feed sheep upon them in the field. The sheep might be netted off, and only allowed

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a small portion at a time, which would prevent them from treading down the plants. Even oats and rye might be fed off in this manner, the sheep being admitted before the plants begin to shoot. Were such land capable of carrying a crop of red clover, it would be most advantageous to sow it without any other crop, and feed it off by sheep confined to a particular spot by nets: in some soils peas, or vetches, will thrive as a first crop, and they may be fed off in the same manner. The first crop upon unimproved land, in general, can only be regarded as valuable, in so far as it yields manure for the fertilization of the soil. Ploughing down the crop does not appear to me so well adapted for this purpose, as feeding it off. When sheep are admitted only to a small part at a time, and are thus gradually carried over the whole field, the chance is that no plants will be lost, and that their dung and urine will be equally distributed over the whole. In certain situations two or three crops may be fed off in this manner, during one season; and in addition to the manure, which is certainly, in this case, the principal object, nearly as much value will be added to the live stock as will repay all the expence.

5. *Rushes, Ant Hills, and rough, or coarse Pastures.*—We have already recommended burning coarse herbage, in certain cases, when it does not admit the plough; but when land is pared, a thin sod is taken off either by a paring spade, or paring plough, over the whole surface. The sod being dried, is burnt in small heaps, and the ashes scattered over the whole field. Swampy land, that is overrun with rushes and coarse grasses, and lands that are covered with heath, ling, and other coarse plants, answer best for paring and burning. This practice destroys these coarse plants at once, and admits the land to be ploughed and cropped immediately, without waiting for the rotting of the turf, as in the former case; it is also said to destroy all slugs and other vermin which infest the soil. In many places they pare and burn even their sweet pastures every time they are broken up for a crop.

Every place has its own practices, and advocates who extol and recommend them. Paring and burning is by many esteemed a most important improvement. There are, doubtless, lands so much overrun with coarse herbage, that they cannot be so easily reduced into culture by any other mode, as by paring and burning. But after the land is once rendered cultivable, I conceive that the paring and burning ought never to be repeated; the result of many experiments which I tried on this point is, that though paring and burning causes the land to yield a good crop or two, it always reduces it to a very sterile state afterwards. Were the land cultivated for grass alone, to be

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depastured by sheep, perhaps paring and burning might be admitted in situations where lime and other manures are not to be procured; but in all cases, where crops are the object, paring and burning reduce the soil to a *caput mortuum.*

I would suggest another mode of conducting this operation, that promises to prove much more advantageous than the former. After the turf is cut from the surface of coarse land, which is meant to be reclaimed, I would collect it all into heaps, in different parts of the field, and make it up into compost with lime. The turfs should be completely drenched with water when the lime is applied; they should be frequently turned and champed among the lime, and during these operations receive as much water as they can retain. By these means they would soon be reduced into a manure of the most excellent quality; every vegetable fibre would be rotted, and changed into subsistence for other vegetables. At the last turning, as the lime must now have lost most of its causticity, as much dung, or other putrescent manure as can be spared, may be mixed with the compost. Meanwhile, the land may be fallowed and levelled, the stones picked out, concealed and sloped drains made, and every thing done that is necessary to render it ever after cultivable. Lastly, the compost should be equally replaced over the whole surface, and the land may carry a crop of wheat.

This is making use of lime in place of fire, to reduce the vegetable matter in the soil; and surely no doubt can be entertained which is the most advantageous. Fire wastes and dissipates the vegetable matter, but lime wastes nothing.

There are certain cold tilly soils, which it is very difficult to reduce into a state of fertility. The great defect of such soils is a perpetual dampness, arising from the retension of water below, and which prevents their staple from acquiring a sufficient depth. An instrument called a miner has been successfully employed to cut out ruts in the bottoms of the furrows, when the land is cross ploughed, and also to deepen the water furrows, so as more effectually to discharge the water. These ruts divide the ridges into small chequers, and although they are covered again with the soil, they still retain such a degree of openness as to permit water slowly to percolate. A rope of straw, or hay, placed here and there into these ruts, converts them into permanent concealed drains.

The following method is proposed for the consideration of those who may have occasion to break up such soils from a state of nature, or when they are covered with rushes and coarse herbage.

The rushes, &c. being cut down with a scythe, and removed, with a strong plough

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that penetrates to a great depth, draw two deep furrows laid up against each other, and destined to form the crown of a ridge. With a paring plough, or spade, follow the plough, and strip off a sod of about an inch in thickness, and the breadth of a fur-slice. This sod being thrown into the bottom of the furrow previously made, with the heathy or rushy side undermost, can be trod down by a man who follows the spade, or paring plough. Lastly, the strong plough should follow the paring plough, and heave up the earth, which it had laid bare, to the depth of about a foot, throwing it over upon the sod previously placed in the opposite furrow.

It is presumed that a sod composed of short heath, rushes, or other coarse herbage, being buried at such a depth below the surface, would ever after keep the soil open, allow the water to percolate, while a great depth of soil would be obtained.

The section of a ridge done in this way would appear as follows:

A B, clay raised by the plough to the depth of one foot.

C D, heathy, or rushy sod, one inch in thickness, placed in the bottom of the ruts, with the herbage strewed under it. The intention of this is to allow the water slowly to percolate either longitudinally along the bottom of these furrows, or laterally towards the water-furrows at C and D.

Perhaps it may be better to scoop out a small rut at regular distances in the bottom of some of the furrows, with a miner or other similar instrument; to fill these ruts with the heath, rushes, or other coarse herbage, and then throw the paring of sod over them as before. Each rut, thus scooped out and filled, would operate ever after as a concealed drain to convey the water along the bottom of the ridge, while the sod would serve the purpose of a lid, or cover, to prevent the earth from filling up and stopping the drains.

The section of a ridge done in this way would appear as in the annexed figure.

A B, clay as before.

C D, the sod stripped, and thrown into the bottoms of the furrows, while the ridge is forming.

E F G, three angular ruts, scooped out by an instrument at regular distances in the bottoms of furrows, and filled with heath, rushes, or straw.

These longitudinal ruts may be intercepted at regular distances by cross ruts, represented by the dotted line H K, by which the water they contain may be conveyed into the water-furrows between the ridges, and so discharged.

It is presumed, that by these means, the most obdurate and irreclaimable clay, being kept open below, and free from moisture, may soon acquire all the properties of a soil of the greatest depth and fertility.

Though these things may be executed by ploughs, and other instruments, properly constructed, yet doubtless they can be done much more neatly by the spade.

I have been told that the late Sir James Stewart, of Coltness, author of the Political Economy, tried an experiment upon some very obdurate land of this sort, which proved highly successful. He ploughed his land from its natural state; the fur-slices remaining hard and adhesive, they were cross-ploughed, or cut across by an instrument; the pieces of clay were then gathered by the hand, and built up into long dykes like those that compose a shepherd's fold. The subsoil, being thus laid bare, was ploughed, or wrought with the spade, limed, &c. After the dykes had mouldered down by the action of air and weather, they were made into compost with lime, and restored to their former situation. His soil consisted of a thin paring of muirish earth, upon an aluminous, and pyritical clay of great depth: it was fit for nothing but making bricks; but by this process was reduced into a friable fertile soil. In the essay on manures, I had recommended trying this experiment with certain soils of that nature, without knowing that it ever had been practised.

I presume that some of these modes of paring, and reducing the turf into a rotten friable state, by the joint action of air and lime, will be found much more beneficial, though perhaps more slow, than having recourse to fire.

6. *Of repeated Ploughings, or of fallowing unreclaimed Lands.*—Many farmers regard fallowing as the greatest improvement that ever was introduced into the agricultural art; by others it is either unknown, or is despised as an unnecessary waste of labour, and a sacrifice of the produce of the land. Much of the contrariety of opinions, which prevails on this subject, may be accounted for, from the quality of the soil on which the farmer operates, or from his local situation. Strong clays require a more frequent repetition of fallow, than those soils that are dry and friable, from containing a great proportion of sand. In those districts where excessive rains abound during summer, it

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is seldom convenient for the farmer to be encumbered with too great a proportion of fallow, as it is often impossible to get it properly wrought, while the land is turned into a mire, if the finest parts of the soil be not washed away. In such situations green crops, adapted to the quality of the soil, are, in general, the most eligible mode of fallowing. As in such districts pasturage ought to be the principal object, so this mode of fallowing is calculated to provide for the wants of the live stock in winter, as well as in summer. There is no soil, or situation, where naked fallowing might not be rendered less frequently necessary, if not wholly superseded, by adopting a proper rotation of crops. Were a drilled green or pulse crop interposed between every two corn crops, the land would always be kept clean and in fine tilth, and a much greater value would be extracted from the same quantity of manure.

As the quality of the soil ought ever to be considered in deciding the species of fallow for which it is best adapted, so the quality of the soil ought also to determine the mode by which the fallowing ought to be conducted. Some soils ought always to be turned up before winter, that their parts may be split and pulverised by the frost; others should not be stirred until spring, as excessive pulverization renders them liable to become miry with rain, which chills the crop, and they consolidate into a hard mass at the approach of drought. Thus, it is more convenient to have such soils rather broken into small pieces, than reduced to a fine powder; but where the object in view is a drilled crop, I believe it is always advantageous to turn over the land before winter, or even to give it a stirring or two during that season, because working it in drills afterwards prevents the effects already stated.

For land already in cultivation, the great uses of fallow are to reduce, or preserve the land in a state of fine tilth, to clean it of weeds, and by turning it up to the air, to cause a more perfect putrefraction of the animal and vegetable matter it may contain. This last effect is so clearly ascertained that the most experienced farmers have assured me, that land, which has been repeatedly dunged, has been found to yield a much better crop, in consequence of a fallow, without dung, than from a complete dose of dung without a fallow, and this too, after the productive power of the land had been much exhausted by cropping.

But for land that is to be reclaimed from a natural state, or from a rude and imperfect state of cultivation, a fallow is always indispensably necessary, not only for the reasons mentioned in the course of this essay, but also to level inequalities, and to lay the land into a proper form for future cultivation.

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In my essay upon manures, I stated several physical reasons why certain soils, when first or when afterwards broken up, should be subjected to a complete fallow. These were the causing certain mineral salts, the ingredients of which are contained in such soils, to effloresce: but as I may have occasion to resume the consideration of this subject, it is sufficient to have mentioned it here; and I am only sorry, that my situation and circumstances never permitted me to follow out such speculations to all the extent which their importance demands.

When land is first fallowed, with a view to lay it into proper form, other instruments beside the plough are frequently necessary. I have seen many levelling machines, for reducing inequalities, and for scooping out slope drains, where necessary in a field; but I never saw any that did not do infinite mischief to the land on which they were used. They require immense force; of course, every animal that drags them sinks to the knees at every step, and leaves holes in the soil, in which water will lodge for ever. They leave no choice of the spot where what is dragged out of one place is to be deposited. The nearest hollow is the spot where, right or wrong, the contents of such machines must be dropped. Where such machines operate upon deep, loamy, and friable soils, they may do no michief, though all their effects may be attained in a much more cheap and economical manner; but I have seen some land wholly spoiled, and rendered unproductive, by the use of such machines.

Before land is levelled or sloped, being previously ploughed, the different qualities of its soil should be accurately inspected, and the different materials that are taken up ought to be deposited in those places which are most opposite to them in quality. Thus sand, gravel, or rich earth, oughtto be dropped upon stubborn clay, and *vice-versâ.* If there be a patch of bog, or moss, being previously under-drained, if necessary, it should be sloped so as to discharge the superficial water. The earth taken out of such places will amply repay the expence, for it will operate as a manure to the other parts of the land. Still more will it operate in this way, if made into compost with lime, or dung, or both, and frequently turned until the parts are completely rotted and incorporated: throwing water upon it, during the turning, hastens the putrefaction of its vegetable matter. We every where meet with patches of bog, or moss, interposed in the corners of arable fields, which are never touched by the plough. Though they be under-drained, they are seldom sloped so as to discharge the superficial water. The farmer does not know that such places are magazines of manure for his other lands. As it would be proper to lay the earth taken from such places on the solid

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land, so it would also be proper to lay what is taken from the solid land upon bog or moss.

The most economical way of removing earth, with which I am acquainted, is by wheelbarrows running upon coarse deals, or by light single horse carts, or small carriages, runing upon low broad wheels, or rollers, and drawn by a single horse. High vehicles, such as the English waggons, occasion an immense waste of power in raising the earth to an unnecessary elevation. When the distance does not exceed 15 or 20 yards, wheelbarrows are most economical; though it has already been observed, that the object should not be to throw down what is removed upon the nearest spot, but upon that spot where it will contribute most to the melioration of the soil. When earth is once lifted, the additional carriage which this may sometimes require is of no importance compared with the magnitude of the object. Where the subsoil is very bad, the superficial soil may be laid aside with the spade, and only the subsoil removed. If in levelling a piece of land, it be found necessary to expose an aluminous, or pyritical subsoil, it should be laid up in drills, or trenched with the spade, the pieces laid in drills, or built like dykes, and allowed to remain in this state during a winter or two; when afterwards levelled, such spots may receive a double portion of lime and dung. There will be no loss occasioned by not sowing spots where nothing will grow.

When high ridges prevail in a rich soil of great depth, they may be levelled without danger during the course of a fallow. Where there is only a thin paring of superficial soil, with a very bad subsoil, it is often dangerous to attempt this by the plough, as it buries down all the good soil, and throws up the bad; yet, these high ridges are a great nuisance to land; their furrows are generally canals, or reservoirs of water; their sides are pared and scratched to the bare bone, in order to accumulate soil upon the top, where it is become, in the language of the farmers, *deaf*, or *douf:* thus very little grows upon the sides of such ridges, and the top either labours under defect of moisture, or the crop gets too rank and lodges. They have still another defect, that grain never ripens equally on all parts of them.

The great object, in such cases, is to get the land reduced to a level, and yet to distribute the good soil at an equal depth over every part of it.

I have seen farmers use a levelling machine, or drag, for this purpose, drawn by a great force of cattle: this instrument may do no harm where the good soil is of great depth, but on such as I have seen it used, it is impossible to contrive any thing more pernicious.

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A thorough trench delving with the spade is certainly the most effectual, and likely to prove, in the end, the most prófitable method of reducing high ridges, as it admits of an equable distribution of the good soil. There is another method with the spade much cheaper than a complete trenching, as no more of the earth is removed than is necessary to raise the furrows on each side to the level of the ridges; the one is lowered while the other is raised. In doing this, the superficial soil on the top of the ridge is laid aside; then the bad soil under it is thrown into the furrows on each side, until by raising the one, and lowering the other, they are brought to a level. Meanwhile the good soil is tossed and scattered so as equally to cover the whole. The land should then undergo a complete fallow with the plough.

Dr. Anderson, in his Essays on Rural Affairs, describes a method of effecting this object, partly by the spade and partly by the plough. The plough is dragged across the ridges, and turns over a fur-slice of superficial soil: at every ridge, or such number of ridges as he can command, is stationed a man with a spade, who, before the return of the plough, scoops out the subsoil from the bottom of the rut on the top of the ridge, and throws it into the water-furrows on each side, until by lowering the ridge, and raising the furrows, the whole is reduced to a level. This method is upon the same principle with the one just described, except that the plough is used for laying aside the superficial soil. It seems to have succeeded very well; but it requires a great number of hands, which in many situations a farmer cannot command.

When ridges are to be levelled with the plough, they should be cleft during the course of one, two, or three crops, by a plough which penetrates to a great depth. The old water-furrows should always be kept clear, and thus one ridge will be converted into two: when they are brought pretty near a level, the land may undergo a complete fallow, being stirred to a great depth before winter, and the levelling finished during the progress of the fallow; but in few cases is it adviseable to plough down high ridges all at once.

Mr. John M'Kenzie, at Glasgow, invented a mode of fallowing by drills, which is certainly the best of any yet attempted by the plough, either for levelling cold bottomed ridges, or for pulverising stubborn clay soils already in a level state. It requires considerable dexterity in the ploughman; and the proprietors and farmers of Great Britain cannot do a more beneficial thing for their country, than by praise and rewards to excite a spirit of emulation among that most useful class of men, the ploughmen, to acquire a skilful management of that important ins rument.

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In performing this operation, the water furrows are first gone round, and ploughed in, on each side, so as to form a drill, when the third fur-slice from the rut thus made, on each side, is raised, and thrown upon the second: this, a skilful ploughman can do by his eye, with great exactness; but if he cannot trust his eye, he may have a cross spar nailed on the beam of his plough, to mark out the distance from the former rut, at which a slice ought to be raised. As the plough only stirs a third of the land by this first operation, it may go over about three acres in one day, laying it all dry, and in a condition to be fallowed ever after, in the wettest weather that cattle can work, without any danger of poaching. After the land is thus marked out, the cattle ever after, walk in the ruts, between the drills, and hence their feet never poach the stirred land.

We have then got the third fur-slice from the rut at which the operation commenced, raised, and laid upon the second, while the first and second remain unstirred, and the first is also uncovered. The plough in its second passage, throws the first slice upon the back of the third, previously laid upon the top of the second. This converts all the land into red earth, and the third passage of the plough stirs the remaining second fur-slice with the third that rests upon it, throwing them in the same direction. Thus all the land is stirred, and assumes the appearance of three-furred drills, the equality and neatness of which depend much upon the accuracy of the first operation in marking them out. The land may now be wrought either backwards, or forwards, as may be necessary to bring it to a complete level, the horses all the while walking in the bottoms of the ruts between the drills.

Fig. 1. Fig. 2. Fig. 3.

A 1 2 3 1 2 3 2 1 3 2 1 A 1 2 3 1 2 3 2 1 3 2 1 A 1 2 3 1 2 3 2 1 3 2 1 A

Fig. 1. A A, is the section of a ridge to be levelled, or if the land be already level, it is a bout, or strech of land, that has undergone the first operation of drill fallow. If it be a ridge, the water furrows A A, are first ploughed in, so as to form single bout drills; then the third fur-slice from the rut on each side is raised by the plough, and laid upon the second, and this is continued until the whole ridge, or stretch, is marked out. This lays the land perfectly dry, having a rut at every third furrow.

Fig. 2, is the same land after being twice gone through witb the plough. In this second operation the fur-slice, No. 1. is stirred, and all the land becomes red earth: because, though No. 2. yet remains unstirred, it was previously covered by No. 3.

Fig. 3. is the same land after the third ploughing. In this No 2. is stirred, and the whose soil is now moved by the plough. The land now assumes the appearance of three furred drills. If it be now level, the drills may be reduced by a brake barrow and marked out again in some other direction, so as to have the effect of cross ploughing; only the direction must be such, that the water may be discharged from them. In this way the land may be ploughed in various directions, and wrought in drills during the whole course of a fallow.

This mode of fallow causes a violent vegetation of weeds, because, by exposing more surface to the air, it brings more of their seeds within that distance from the atmospherical influence, where their vegetation commences. By stirring only one fur-slice out of three at a time, every slice has full opportunity of meliorating by the influence of sun and air, before another is thrown upon its back; it also renders the fallow wholly independent of excessive rains, which often render fallowing impracticable.

When the land is brought to a perfect level, the weeds should be destroyed by a strong brake harrow dragged across the drills. This will reduce the land to a smooth surface, in which state it may be allowed to remain until more weeds spring up: but if excessive rains should surprise the land in this state, a plough can be sent through to mark out new drills as before, which will render the whole dry.

In fallowing, cross-ploughing is essentially requisite, to cut the roots of weeds in an opposite direction, and to present new surfaces of the soil to the air. Now, by this mode of fallow, cross ploughing can be affected with greater advantage by drills crossing the former, and marked out after the land is laid smooth by the brake: such drills should always be so drawn as to discharge the water. Thus a field may be ploughed in several different directions, always keeping it in drills, and remain, independent of the weather. After land is cross-ploughed in the ordinary way, it often happens that excessive rains render it a perfect mire, and it is frequently unworkable during that season. In the fallow by drills this can have no place; and should the weather be too wet, at the time it comes to be ridged, to admit of smoothing the drills, the ridges can be formed of a certain number of drills thrown together.

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In executing this mode of fallow, care should be taken always to make the furrows clean, so that no clods, or earth, may fall back and cause water to stagnate in the ruts. When very high ridges are suddenly levelled by this mode of fallow, it is obvious that the good soil will be buried down, as happens in every mode of levelling with the plough; but the fresh soil that is turned up, being brought in succession within the influence of the atmosphere, and always worked in drills, is much sooner meliorated than by the method of close ploughing. If, however, the ridges be very high, it is safest to split and reduce them considerably in the course of cropping, previous to their being effectually levelled. When the levelling at last commences, it is proper to get through as much of it as possible before winter, that the new soil which is turned up may receive the benefit of the frost. With these precautions, high ridges levelled by a drill fallow will discover no inequality in their subsequent fertility. It is hardly necessary to observe, that in all modes of levelling high ridges, the old water furrows should be raised somewhat higher than the old crowns of the ridges; as the soil in the former, being very loose, subsides, and if not in sufficient quantity, would again become a hollow.

In many parts of the Lothians, they have a practice somewhat similar to this mode of fallow, of ribbing the land that is intended for barley before winter sets in. This is done by laying one fur-slice upon another, which remains unstirred, and it divides the whole land into very narrow drills. These keep it perfectly dry during winter, and admit the frost to the bottom of the soil. On clay lands, and such as have a cold bottom, this is found to be very beneficial, for barley does not thrive on such soils unless they be finely pulverized.

8. *General Remarks.*—All obstructions being thus removed, the land levelled and reduced by repeated ploughings into a state of high tilth, now is the time to apply manures. When land is newly reduced from a state of nature, a very considerable dose of lime, or other calcareous substance, is absolutely necessary: but a person who enters upon the improvement of an extensive waste, ought to beware of severe cropping at the first time he goes over the land. This would be acting like the Americans; exhausting the natural power of production inherent in the soil, and leaving it in a worse state than it was before.

To make the land permanently fertile, a considerable quantity of putrescent manure is as necessary as calcareous earth. The improver ought therefore to hasten to get his lands into grass as soon as possible after the first breaking up. Lime and working

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give grass, and grass enables the improver to increase the amount of his live-stock, and thus to accumulate putrescent manure.

With this view the dry and friable soils may be sown with turnips, and fed off by sheep, or by cows in the house. Other soils may be sown with grass, along with a corn crop, when ready at the usual season of sowing; but whenever the fallowing is completed, and the land ridged, at any time betwixt the months of June and September, when it is now too late for sowing corn, I would recommend to proceed immediately to sow grass, red clover, grey oats, buck wheat, or other crop of that nature, and eat it down by sheep as soon as they can bite without tearing the crop out by the roots. They may be netted, or hurdled, upon such a crop, in the same way as upon turnips; and the soil being well limed and pulverized, will be in an excellent condition to imbibe their urine and dung.

Dr. Anderson strongly recommends fertilizing waste land by folding sheep upon it. Without sufficient experience of my own to decide in this matter, I shall only observe, that persons on whose knowledge I relied, have affirmed, that folding does more injury to the stock, than the value it conveys to the land. There is a sort of voluntary folding, which I have often seen practised by shepherds. They slowly drive their flock to a particular spot, and walk round them until they begin to lie down. When their bellies are full, they generally find them in the same spot next morning. But without pretending to decide, it would certainly be advantageous to have the land on which sheep are to be folded, previously fallowed, and reduced to proper form, that their tath may never afterwards be buried down. If the land be thus fallowed, why not sow it with some plant that the sheep will eat? And if they be conveyed gradually over such a field by nets or hurdles, all the advantages of folding will be acquired, without any restraint put upon the animals.

When the weather is not too wet, sheep ought always to have free access to lands that are undergoing the process of fallowing. They deposite manure, and they eat up a vast quantity of weeds and roots. Swine may also be occasionally admitted to devour the roots of certain weeds.

When the land is thus speedily brought into grass, an ample fund of subsistence is provided for the cattle that are employed in subduing the yet unreclaimed waste. Portions of the manure that is accumulated about the stables may be made into composts, as top dressings for the parts that are thrown into pasture. When a whole tract of waste land is gone over in this manner, it will be in proper order for being

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subjected to a regular rotation of crops; or for that particular management which is best adapted for grazing and the dairy, according as climate, situation, and other circumstances, may render most expedient.

SECTION II.

On improving Natural Grasses.

The methods already detailed are proper to be adopted where land is not too much elevated above the level of the sea, or where local position in regard to markets, renders it expedient, that it should be reduced into the highest possible state of improvement; but there are vast tracts of muirland in this country, too remote from roads and means of communication, to admit of the more expensive modes of improvement, or too much elevated above the level of the sea, to admit of ripening, and bringing grain to maturity. For such lands, the extinction of heath and of coarse grasses, and causing them to throw up a sweet and palatable herbage, ought to be the first, if not the only improvement that is attempted. Happily, this can be very speedily affected, and at an expence which the improvement will amply repay.

The lands I talk of, are generally covered with a stratum of black, mossy, or peat soil, incumbent on a sterile till. The till is sometimes blue from *petrolium*, generally white when first turned up, but becomes yellow, or brown, by long exposure to the air. Sometimes it is yellow or reddish when first turned up. In fact, such subsoils are composed of the remains of indurated schistus, which has been softened by long exposure to moisture. Where sulphur of magnesia abounds in such clays, working, and exposure to the air, render them fertile; but the predominating ingredients in them are sulphur of alumine, and of iron; and to the efflorescence of the latter we must impute their change of colour by exposure to the air.*

Of shrubs, these soils carry the heath and gall plants, and it is remarkable, that the latter shrub is confined to the western side of the island; at least, I may be permitted to say, that though I have seen the gall plant abounding in uncultivated lands on the western side, I never saw it on the eastern side of the island. The grasses which such lands carry are fog, or growing moss, bent, ling, and other unpalatable grasses, of which

* See Essay on Manures.

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there are many species. In places where water stagnates or oozes out from subterraneous strata, they also carry rushes, sprits, and other aquatic plants. In elevated situations such lands are commonly pastured by sheep, to whom they afford a very unsubstantial nourishment. The fog, or moss, and the roots of the coarse grasses, retain water like a sponge; hence, in wet, or damp weather, the poor animals are perpetually plashing to the bellies in water, nor have they even a dry place to lay themselves down. As the water that falls from the heavens cannot sink through the subsoil, nor get easily away from the surface, a great part of it remains, until it is carried off by evaporation; hence such lands are generally colder than the temperature of the climate would lead us to expect; for it is well known that evaporation produces cold, in other words, causes an absorption of heat. From the perpetual dampness of such soils, they are incapable of sustaining any but those hardy plants, with which the author of nature has clothed even the solid rocks and the most sterile soils, and which retard the progress of that law, by which the elevated land is perpetually washed into the sea.

Among the Cheviot hills, I observed that the farmers are attentive to drain the rushy places, which are frequent at the bottoms and sides of hills. This they do by a small narrow rut, cut out by the spade, aslant, in the part where the springs break out. The rut also intercepts the superficial water which flows down from the higher parts, and inundates those parts which spread into a flat; but in certain cases boring, and concealed drains, would be necessary, effectually to drain such spots as are infested by subterraneous springs. In all cases, superficial water may be discharged, and the pasture rendered sweet and palatable, by adopting the following method.

On the farm of Birnie-hall, in the upper part of Lanarkshire, I selected a field of $17\frac{1}{2}$ Scotch acres for trying this experiment. It was about 900 feet above the level of the sea, as ascertained by the levels of the intended canal between Edinburgh and Glasgow. In some places it consisted of peat bog of unknown depth; in others the peat was very thin, with white till, below; in others the till was the superficial stratum.

In some places the ground carried a thick matting of whitish fog, or growing moss; in others there grew sprits, rushes, and aquatic grasses; in others, heath, bent, ling, and other coarse grasses, which abound in muirs; in some places the water was stagnant upon it, and in such cases, we were obliged to make bridges of rushes to enable horses to walk over it. Having very little declivity, in all places the slightest shower rendered it a mire, the water being detained among the roots of coarse herbage, and having no other way of getting off, but by evaporation. The only use that had ever

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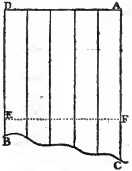
been made of this field, was to scratch some parts of it for a scanty supply of wretched meadow hay, and to pasture it occasionally by young cattle. Taking it *in cumulo*, a shilling per acre would have been a very high rent for it.

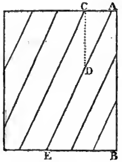
1. In order to render the ground perfectly dry, it was cut at the distance of every 10 or 12 feet by the shear-feather plough, formerly mentioned. This is the common Scotch plough, with a feathered sock edged with steel, and having also an angular feather, edged with steel, fastened upon the wrest. The feather upon the sock cuts the matted roots of the coarse herbage below, and the fur-slice being heaved up by the plough, the feather upon the wrest cuts the roots by which it adheres to the opposite edge, and throws it clear of the rut. Thus the fur-slice is in no danger of falling back behind the plough, which would happen if the plough were not armed with these feathers. We generally employed three, and sometimes four horses, with a driver, in cutting these ruts. Where the land happened to be so wet that horses were in danger of sinking, they were sent round to the next firm station in the line, and the plough carried after them upon men's shoulders: such places were afterwards laid dry by ruts cut with the spade, and wherever a small natural watercourse intersected the ruts, it was either cleaned out afterwards by the plough, or the spade. The horses were always yoked abreast, because we soon found, that when yoked in the common manner, the hind horses mired when they came to tread upon the footsteps of the fore-horses. Many other species of ploughs may be used for performing this operation; and when ruts are cut in muirs covered with strong heath, perhaps six, or eight, horses may be necessary to draw the plough.



A B, represents a field cut into parallel spaces, in this manner, where the furrows are

made to terminate in the natural watercourse, or hollow, B C, which ought to be cleaned either with the plough or spade. It is obvious that all the water which falls upon the field A B, will soon be discharged by the furrows, and run off by the watercourse B C. If a muir be very extensive, it may be proper to deepen and widen the upper cross rut A D, so as to intercept and carry off all the water that runs down from the higher ground; but such ruts should never be so large as to endanger the miring of sheep and lambs. If the hollow B C, be so soft that cattle cannot approach it, the parallel ruts may be intercepted by a cross rut E F, and the water conducted by a spade into the watercourse B C, from that part of the cross rut where it accumulates most. Thus an extensive muir may be marked out into spaces of, from ten to twelve acres, and if it be afterwards inclosed, the ruts will point out the line of the fences.

Where the field has little sensible declivity, it is best to cut it in the line of the declivity, and vary the direction of the furrows as this is found to vary: but if the ground has a considerable declivity, I would recommend cutting it obliquely to the line of declivity, as the water that falls will thus get sooner into a rut, and be discharged.



Thus, suppose A B the line of declivity, it is obvious that were the field cut by ruts parallel to this line, water falling at C, might run the whole length of a parallel space before it gets into a rut. But being cut obliquely, the water following the line of declivity C D, gets off by the rut D E. As the object is to get the water discharged as speedily as possible, every person of judgment will vary the direction of his furrows according to local circumstances.

Note, that thus drawing off the water retained among the coarse herbage in muir-

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lands, is a great object gained, although the improvement should go no farther. It helps to correct the dampness of the soil, renders it more comfortable, and the grass more palatable, to sheep and cattle.

2. The field on which the experiment was tried, being laid dry in the manner described, men were sent through with spades to cut the fur-slices into lengths of from 2 to 3 feet, and to turn them on edge to dry. This operation costs 2*s.* per acre. Some time afterwards women were sent through to build them on end, in small parcels, called here *footing*, being the way in which peats are dried. When they seemed sufficiently dry, a man with a number of women, furnished with wheel-barrows and pitch-forks were employed to collect and build the pieces into large conical heaps, having a small hollow, or chimney, down the center, and an air hole below exposed to the wind. This operation commenced to the leeward, and as soon as a heap was completed, it was set on fire by a lighted peat, or by a blaze of dry rushes, or of coarse grasses found upon the spot. Sometimes we were obliged to kindle a fire of dried peats within these heaps to make them take fire; but what appeared singular, and exceeded my expectation, heaps, wholly composed of clay, after the coarse herbage on their surface was fairly kindled, burnt as well as those of moss, and left a very large proportion of ashes. When the heaps had burnt to the ground, the labourers continued about a week to stir the remaining clods with pitch-forks, until all was burnt, that seemed possible. The women were afterwards employed to spread the ashes from wheel-barrows with shovels, and to lay them as equally over the field as they could.

Note, that though the improvement had stopped here, it seems likely to have been attended with good effects; for it not only laid the land dry, but, it is presumed, that the ashes of the turf, cut out for that purpose, would have operated in sweetening, and increasing the luxuriancy of the herbage that remained untouched. This is making wild land, remote from manures, or too elevated to bear the expence of working, improve itself. There is no doubt but had these turfs been made into compost with lime, and treated as above directed, their effects would have been more conspicuous.

3. While these operations were going on, heaps of lime were placed in different parts of the field, and slaked. After the turfs were removed into the large heaps, it began to be spread. I tried different proportions, from 50 to 100 bolls per acre, and it was found, that what got most, exhibited the best effects. After all the lime and ashes were spread, a single horse plough was sent through the ruts, to clean out any clods, or lime, that might detain water in them.

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Though these operations commenced very early in spring, owing to various interruptions from rains and other avocations, the month of May elapsed before they were completed. A very severe drought had set in; the natural herbage upon the ground had been shrivelled, or burnt up by the burning of the sods, and no vegetation appeared until towards the end of July. Several heavy showers fell about that time, and it was curious to see the hard coarse grasses, with shrivelled tops, springing up in a soft and succulent state: in fact it appeared evident to me, that the lime and ashes had not extinguished the native grasses, but only caused them to become sweet and nourishing.

The spots where the heaps had stood, were burnt into hollows, and from the great quantity of ashes left in them, they threw up a luxuriant crop of sorrel. These hollows should have been filled up with earth, and sown with grass seeds.

I left the management of this farm soon after this experiment was completed; but I afterwards learnt, that they gathered about 2000 stone of hay from the field the first season, of a sweet and nourishing quality, and preferred by cattle to the hay or rye-grass and clover. I returned there the ensuing winter, and found all the muirs soaked with moisture; while this field was so dry and consolidated, that it might have carried loaded waggons. I returned there the third summer, after the experiment was made, and found the heath wholly extirpated, except two small tufts, which, it appeared, the lime had missed. A most luxuriant growth of sweet grasses appeared every where, and of all the species, that are native in our climate; but what surprised me most, the white clover was as thick as if it had been sown: a considerable quantity of thistles and rag-weeds also appeared, which had never been seen there before. I have always found that lime alloyed with sand causes thistles to grow upon the land where it is put; while lime alloyed with clay has not this effect. The lime in this case was alloyed with sand.

Though the gentlemen for whom I acted disapproved of this experiment at the time, yet I understand they have since carried it to a considerable extent on other parts of their muirs, and with great success. I never approved of cutting such grass for hay; but think the best way would be to reserve the land done in this way during spring or summer to be pastured by cattle, or sheep, the ensuing winter. The grass being allowed to cover the lime, would retain that degree of moisture which is favourable to its action upon the soil.

Some eminent storemasters, to whom I proposed this experiment, started an

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objection which I little expected. They said that putting lime upon their muirs would cause their sheep to get fat, and to die of the rot. With regard to sheep getting fat, it is certainly the great object to be attained by pasturing them; and when this happens, the rot may be prevented by consigning them to the butcher: but it never appeared to me that the rot, and other diseases of sheep, are produced by sweet herbage; they seem rather to be caused by the perpetual wetness and dampness of their pasture; evils which this mode of improvement is calculated to obviate.

By adopting this mode of improvement, the extensive muirs which abound in this country may very speedily be converted into sweet pasture. It may be carried up the sides of hills, and cause them to exchange their sable hue for lively green. All these mosses, which are already covered with a coarse herbage, and are sufficiently firm to sustain the tread of labouring cattle, may also be treated in this manner. This mode of improvement is both rapid and cheap, and the advantage great: for the land I allude to was, in the opinion of the most competent judges, rendered worth from 12*s.* to 15*s.* per acre ever after in pasture. The expence could not be exactly ascertained, because the labour, being mostly performed on day wages, was done by fits and starts, when we were not interrupted by rains. It is not necessary that the improver should thus stop short after he has meliorated the quality of his muirlands; if he afterwards finds it expedient to reduce them into tillage, this previous treatment will prove an excellent preparation.

SECTION III.

Of Mosses.

1. *Origin of Moss.*—The celebrated Dr. Anderson, in a late treatise, advances an opinion which appears to me somewhat paradoxical. He asserts that moss is a vegetable, or congeries of vegetables, which are *growing*, or *living* below, while he distinguishes the top, where we frequently see vegetables actually growing, by the epithet of *dead moss.* Thus, according to him, there are two species of moss, *viz.* 1st. *Quick moss*, from which peats are dug, on which no vegetables are ever known to grow, and in which no animals are ever known to exist; that this, before it is cut out of its natural situation, is composed of a congeries of growing, or living, plants. 2d. *Dead*

moss, which frequently covers the former at the surface, on which heath, and fog, and coarse grasses, are seen in a growing state, while insects, and other animals, frequently nestle in it.

The idea seems to have been suggested to the Doctor by the vulgar dialect of some parts of the country, where deep moss, fit for making peats, is often distinguished by the appellation of *quick moss*. But I apprehend that this term, in the vulgar dialect of Scotland, no where indicates life, in the sense affixed to it by the Doctor; and I know of no term used among the vulgar that ascribes life to vegetables of any kind. By the term *quick*, when applied to mosses, I suppose they mean only to express their miring property, just as *quick sands* mean sands in which a passenger is in danger of sinking. *Dead moss*, I conceive to be synonimous with *firm moss*: those parts of peat bogs which are covered with herbage being the only parts on which a passenger can walk, when the moss is wet, as his feet are supported by the matted roots of plants.

But whatever may be the strict meaning of these terms in common language, the Doctor must admit that, according to his hypothesis, this vegetable, during the whole period of its growth, is excluded from the influence of sun and air. No vegetable, I ever heard of, forms ligneous fibres, or acquires inflammability, without contact of air and of the sun's rays during the period of its growth. Now, how comes it, that a vegetable, growing in such extraordinary circumstances, acquires the very high degree of inflammability ascribed to it by the Doctor. Inflammability it cannot acquire from the action of the sun's rays, because it is soaked in water, and frequently covered with a thick coat of what the Doctor calls *dead moss*. However ingenious, therefore, the hypothesis may be, this obstacle to its admission seems, to me, insurmountable.

But what seems decisive of the utter deadness, and partial dissolution of that species of moss, to which the Doctor imputes life and vegetation, is, that such moss emits light when kicked and tossed about in a very dark night. This is well known to those who live contiguous to peat bogs, and is the cause of frequent terrors, which are ascribed to *sponky will of the wisp*, &c. It is really owing to the slow inflammation of the ligneous, or carbonic fibres, of which the moss is chiefly composed, in consequence of contact with atmospheric air in a moist state. No plant, as far as I know, is capable of this spontaneous inflammation while it continues in a growing, or living state; and most plants require all their mucilages, and other soluble parts, to be extracted by long soaking in water, before they are capable of exhibiting this phenomenon. If a piece of wood be well dried and seasoned, it cannot afterwards by rotted except very slowly;

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but if it be sunk, in a green state, among moist earth, its soluble parts are extracted in the course of a few years. Its ligneous fibres become soft, and may be separated in every direction; each species of wood breaking in a way peculiar to itself, both laterally and perpendicularly, similar to the crystallization of salts. If this wood be suddenly exposed to the air, in a dark place, while moist, it will shine with great brilliancy; if it be dried, it would be found much more inflammable than fresh wood of the same species which has been seasoned, as it consists almost wholly of carbon. The property of shining in the dark is common also to leave of trees, and to all vegetables, whose carbonic fibres have been laid open in consequence of long soaking in moisture, when they are first exposed to the action of atmospheric oxygen. By frequent repetition of soaking, and exposure to the air, such bodies become entirely calcined, and they leave an uninflammable earth, such as is produced by burning them in a common fire. No living vegetable, however, and no vegetable whose solution is not pretty far advanced, is ever seen to undergo this spontaneous inflammation; but moss, adapted for making peats, certainly undergoes this process, and therefore such moss, instead of being alive, must be dead.

This may help us to explain a fact, which is ably illustrated by Dr. Anderson, that moss, if frequently turned up to the air, and kept uniformly in a moist, state, though not absolutely soaked, is gradually changed into a fertile soil. None of the succulent, or nutritious vegetables, are known to grow upon other vegetables, unless the putrefaction of the latter be pretty far advanced. Frequent turning of moss, in the given circumstances, exposes it to slow inflammation, or putrefaction; both of these processes being of the same nature.

This may also help to account for some facts which seem to have puzzled Dr. Anderson, as appears from his treatise above referred to: that, oak, which is never found to rot when sunk in moist clay, or moisture of any kind, should be found reduced almost to a pulp in moss; but the Doctor may observe that the oak found in moss was never seasoned; it fell where it grew, and was inclosed by moss with all its natural juices, while a vast quantity of additional juices, retained in the moss, soon invested it on every part. The trees in this situation were in time robbed of all mucilage, and soluble parts, which became food for the moss plants that invested them; of course nothing at last remained but the carbon, or ligneous fibres, saturated with the moss juices. Though the cohesion of these fibres be destroyed, they are insoluble in water, and do not easily rot in it; in other words, they do not readily decompose water.

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But another difficulty still occurs to the Doctor. How come these ligneous fibres to retain their inflammability, or even to have it considerably increased?—A few facts shall be afterwards stated, which may help to account for this; at present is is only necessary to observe, that wood will retain its inflammability a very long time, if buried green in any moist substance, which effectually excludes it from the action of atmospheric air, provided it does not petrify, or change into stone. Its soluble parts may be extracted, and diffused through the water; but they rather impede, than increase the inflammable power of wood. The ligneous fibres, however, remain, and are not rotted, except by the joint action of air and moisture. It has often been observed, that the part of a stake fixed in the ground, which soonest rots, is a ring from the surface downwards, which is between the wet and the dry; that is, the part which is exposed to the joint action of the earth's moisture and of atmospheric air. Now trees that are buried deep in moss are soaked in perpetual moisture, but are excluded from the action of air: they cannot therefore be said to rot, though their parts should be softened, and their soluble mucilages be extracted, and dissolved in the water; but any one who examines the large trees found at the bottom of mosses, must be convinced that they had undergone a partial rotting before they were completely covered by the moss. The upper part of these trees is uniformly flat, or eat out into hollows, while the under part retains its natural rotundity. This shews, that after these trees had fallen, the under part was immediately invested, or sunk in moss, while the upper part continued a long time between the wet and the dry, before the moss grew up and excluded the action of the air.

If then the ligneous fibres of wood sunk in moss remain undecomposed, their being softened, and reduced to a pulpy state by long maceration in water, affords no reason why they should lose their inflammability, but rather that this quality should be increased. Inflammability can only be lost, in consequence of the carbon contained in a body having combined with oxygen; a combination which, in this situation, cannot take place; nor does there seem sufficient reason to conclude, that the plants, of which moss is composed, grow in a different manner from other plants, or that they acquire a high degree of inflammability without the action of sun and air; a supposition which is contrary to universal experience.

But without entering into any controversy upon the subject, I may be allowed to state my own opinion, with the reasons on which it is founded. Far from laying claim to infallibility, the reader is requested to withould his assent, unless the facts adduced may seem to him convincing.

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And first, there is one opinion in which I cordially agree with Dr. Anderson, that moss grows, or receives a gradual accumulation from vegetation. The only point in which we differ, is respecting the place where this vegetative accumulation is made: he says it takes place below, while I apprehend it takes place at the surface.

But with regard to the general fact. That moss grows, many proofs are adduced by Dr. Anderson and other writers; and I shall only superadd two, which appear satisfactory. In a moss belonging to Robert Fulton, Esq. of Hartfield, near Paisley, the people, in casting peats, came upon a causey formed of broad stones upon moss: this causey had been very substantially finished with stones brought from a distance, in the Roman manner, and was probably constructed by them while they occupied a fortified camp at Paisley. Though it had been originally laid upon moss, a new covering of moss had grown over it, to the depth of several feet. There is a moss at Swinridge Muir, from which peats had been dug at some very remote period: the old pots, from which the peats had been taken, are grown up to the level of the surrounding moss; but on leading up a main drain, which passed through several of these holes, they were found to be filled with moss of a more soft and spongy texture than the old moss, which never had been dug. Indeed the new moss no where coalesced with the old, the sides of the pots remaining perpendicular and entire. The new moss could not have been accumulated from any thing blown into the pots by the wind, as the whole surface of the surrounding mosses were covered with heath and coarse herbage; it must therefore have been caused by a new vegetation of moss in the holes from which the peats had been taken.

Were a naked rock suddenly thrown up from the sea, or from the bowels of the earth, the first plants which Nature would place upon it would be the various species of lichens, and such as can subsist wholly upon what they imbibe from the air, without needing a soil in which to push their roots. These plants serve the double purpose of clothing the rock, and thus preventing the fine particles that are dissolved by air and moisture from being washed away, and from their growth and dissolution, of accumulating vegetable soil for the sustenance of more succulent plants. The rock is thus gradually made to acquire such a depth of soil, that it becomes able to sustain, not only grasses and shrubs, but may become a receptacle for the oak itself.

But if we suppose this rock to be so situated, that moisture cannot easily run off from its surface, a great variety of the moss plants will begin to grow upon it. As these accumulate, the moisture will rise along with them; for they retain it like a

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sponge, and obstruct its passage from the rock. Thus as long as the moss plants can accumulate moisture, they will continue to grow, until the rock comes to be covered with a deep moss.

The same effect will be produced upon a bottom of gravel, or limestone, which does not easily admit the moisture to pass through it. Upon a bottom of aluminous, or pyritical schistus, none but the most hardy plants, such as those which compose moss, can exist; and such plants will therefore accumulate upon such a soil, if not checked, even though it should have a considerable declivity.

Upon flat clay land, and in hollows, that had been formerly covered with wood, we uniformly find mosses which have grown in consequence of the wood having been felled, or allowed to fall down. This is owing to the water having been obstructed by the trees, after they had been strewed upon the ground, and which consequently caused the production of aquatic plants. But such trees as we find in the bottom of mosses, being steeped in water, throw out a considerable portion of the tanning principle: this is of such a nature, that no other but the hardy moss plants can grow in a soil affected by it: such plants, therefore, rapidly grow in such situations, and accumulate as long as they can cause the moisture to rise, as they rise. In the bottom of mosses, that had been originally caused by the fall of woods, we find all those grasses and plants which commonly grow in woods, in a state of preservation; we also find the leaves and other exuviæ of the trees, which having been dropped during a course of ages, seem not only to have increased the dampness of the soil, but by their astringent juices to have predisposed the soil for the growth of moss plants; thus the moss seems to have advanced a considerable way before the trees fell, and by the moisture which it retained, it seems to have chilled their roots, and rendered it easy for the winds to overthrow them.

Mosses in flat situations are generally highest in the centre, that being the point where the water finds most obstruction to its running off. The limit to the farther accumulation of these mosses is the point to which the water can be drawn up as the moss increases, and they have been known to grow until the column of water, sustained in the moss, has burst its barriers, and conveyed the moss that retained it over the neighbouring fields. Many examples of this might be specified, but I shall only mention that of the Solway moss, the facts relative to which are well known to the public. To this cause also moss hags are to be imputed, or those dangerous chasms which frequently occur in deep mosses: these are produced by a part of the moss shifting its

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position, from the column of water sustained in it acquiring greater pressure than the lateral resistance. Thus moss may be considered as a fresh water sponge, which grows as long as it can draw up, and sustain water to nourish it.

The predisposing causes of the growth of moss appear therefore to be an extreme degree of dampness, or of astringency, in the soil, which render it an unfit receptacle for any other, but the moss plants. I uniformly proceed upon the supposition that the sperm, the seeds, or the suckers of the moss plants are at hand, where a soil is thus predisposed for their production; for it would be absurd to suppose, that these plants would begin to grow even in the most favourable situations, if there were neither seeds nor roots from which they were to spring. We are told that in America, and several other countries, peat bogs are unknown: this I would account for in two ways; either the moss plants are there, but never accumulate into a bog, from want of a proper receptacle; or supposing situations favourable for their accumulation, there are neither seeds nor plants of mosses to occupy these situations. We know not all the causes which induced the Supreme Being to diversify the productions of different climates; but we know, that they are exceedingly diversified, and that this operates as a powerful motive upon remote nations to cultivate a friendly intercourse with each other.

The moss plants grow at the surface, with their roots and stems immersed in moisture; but their leaves and branches are exposed to the air, and the sun's rays. Those mosses which discover no vegetation upon their surface, are either arrived at the utmost height at which they can sustain water, and have hence become dry, and are frequently blown about by the winds, or there are large spaces perpetually washed by the rains which fall, which are hence converted into water-courses. In such ruts every new accumulation of moss is washed away, if what was formerly accumulated be not also carried off to a considerable depth. In flat places, where the moisture does not readily get off, the genuine moss plants may be seen growing somewhat similar to the green vegetation which arises in pure water, when exposed to the sun's rays. When a moss is intersected by numerous water-courses, it appears to be divided into islands, on which heath and coarse grasses, with *lichens* and other moss plants, are growing. When a moss has grown so high that it no longer retains a sufficiency of water to cause its farther accumulation, the upper part, being between the wet and the dry, is partially rotted, or decomposed into vegetable earth; hence the upper stratum of moss is never so inflammable as the parts below, having already, in some degree, suffered the slow inflammation which converts it into soil.

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The moss plants seem almost wholly composed of carbonic fibres, and are so hardy that they continue to grow above, while their stems and roots are mouldering below. I have traced many of them to a considerable depth. Thus the yellow, or white, fog, of which there are several varieties, is commonly fresh and vigorous at the surface; about a foot lower, it may exhibit marks of decomposition, though its organization remains entire. It may be frequently traced almost to the bottom of a deep moss, though its organization becomes constantly less distinct, until it is entirely lost. In the same way I have been able to trace the heath plant almost to the bottom of a peat moss; below it becomes soft, and is frequently bruised by the incumbent pressure, but its organization is seldom destroyed.

The plants, which compose moss, are doubtless exceedingly various. Botanists have enumerated more than 300 species of them, of the cryptogamia class; but it is probable that many species of these plants are invisible to the naked eye; and that there are many others, whose form and organization it is difficult to ascertain.

While the moss plants are growing at the surface, they are not rotting below: they are only steeped, or macerated in water, which extracts their soluble ingredients, and reduces them to a soft and pulpy state, in the same way as was mentioned respecting wood. As the water cannot get off except by evaporation, in the lower parts, it is never changed, but the same water must continue for ever in the place which it occupies. Were it otherwise, that is, were the water frequently shifted, the moss would gradually rot, and moulder into earth: hence the effect of watering mosses, which, by accumulating vegetable mould, causes the moss to throw up sweet herbage.

Dr. Anderson thinks that mosses could never accumulate to their present extent, by growing above, while they are rotting below: he thinks that even an acre of the best grass could never accumulate hay sufficient to cover the surface on which it grew, to such a depth as many mosses have attained, by the residuum left after it was rotted.

But it is well known, that by the rotting of hay, and other succulent vegetables, by far the greatest part of their substance is conveyed away in those gasses which are emitted during the process, and there is nothing finally left but a light earth, together with some salts that are formed in the product. In moss, no such rotting process takes place; for we never find that any of those gasses emitted by rotting vegetables are emitted by moss; on the contrary, moss will preserve succulent vegetable, and even animal substances. It is said, that in the Ards moss, in Airshire, bodies of persons have been found by the people who were casting peats, which have remained in a

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perfect state of preservation ever since the persecution of the covenanters by Charles II. The covenanters frequently held their conventicles, or field preachings, on the borders of this moss: when surprised by the king's troops, they fled into the centre of the moss, where cavalry could not pursue them. As these meetings were generally held in the night, it appears that some of these people had dropped into holes, where they could not afterwards be found. It is therefore evident that moss, so far from being itself in a state of putrefaction, is a styptic, whose juices are capable of preserving even those bodies which are naturally most liable to putrefaction; the two cases are therefore altogether dissimilar, and the argument inconclusive.

But if we were to suppose the grass, like the moss plants, growing as thick as it could stand, and every season macerated, but not rotted, in water which fills up every interstice, I apprehend it would soon accumulate upon the soil that produced it, to a much greater depth than any moss now in existence; it may be farther observed, that scarcely one half of the densest moss is filled with vegetable matter. When peats are first cut out, they are nearly double the size they retain after they are dried; and when they are squeezed while wet, by a press, they go into a much smaller form.

But how comes it that water only macerates the moss plants, that is, extracts their soluble ingredients, and destroys the adhesion of their parts, without rotting them, as happens with succulent plants?—I apprehend this must be partly imputed to the hardy nature of the moss plants; for being chiefly composed of ligneous, or carbonic fibres, the water does not readily act upon them, or more properly, is not easily decomposed by them. Those plants are easiest rotted which abound most in mucilages, and parts that are soluble in water; even mucilaginous plants do not easily rot, if they be wholly immersed in water, and excluded from the action of the air, which is precisely the situation of peat moss. But independent of this consideration, we shall see that the water which resides in moss is impregnated with a portion of the tanning principle, which effectually prevents the rotting of the plants, in the proper sense of that word. Moss plants, therefore, are macerated, or infused like tea in water, but not rotted: the organic texture may be destroyed, and the soluble parts diffused in water, without suffering any chemical change: as the same water always resides in the moss, unless it be evaporated, there can be little or no loss of vegetable substance. As this maceration in water does not oxygenate the plants, it should render them more inflammable than when in their organic state, as was suggested respecting wood.

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The trees and shrubs I have found at the bottom of mosses are the following, and they are perhaps the only indigenous trees and shrubs of this country. Of trees, 1. the oak; 2. the elm; 3. the birch; 4. the willow; 5. the aller; 6. the fir. Of shrubs, 1. the hazel; 2. the dwarf willow; 3. the gall-plant; 4. the heath plant: this last frequently continues to grow upon the moss during the whole period of its existence. The 2d. and 3d. shrubs also frequently continue growing upon mosses in the western parts of Scotland: they are very hardy shrubs, and seem to prefer those situations where their roots are immersed in the tanning principle, and the plants themselves abound in this principle.

The shrubs which grow in mosses are always partially decomposed, if they bave not entirely lost their organic form, when traced downwards to a certain depth: but I have also observed certain tubular roots, resembling large threads, whicb are evidently in a living state from the top to the bottom. These roots belong to plants whicb are growing at the surface, and which do not seem to decay below, with the mass of other plants.

In the commencement of many mosses, it would appear, that the falling of leaves and decayed branches, together with the undergrowth of shrubs and coarse grasses, had obstructed the water, and caused the moss plants to grow and advance before the trees fell down. The moss, by its retention of moisture, and by creeping up the stems, seems to have chilled the trees, and brought on their decay, before they fell down: thus we frequently find a considerable depth of moss below the trees, which are often broken over a considerable way above the root, and they generally lie in one direction, owing to the prevailing current of the winds having first bent, and afterwards caused them to fall, in that direction. Mr. Smith shewed me mosses, where oak and elm trees were lying near the bottom, and above tbem hazel and other shrubs had grown, which in their turn had been destroyed and closed round by moss.

As a proof that moss is composed of a congeries of plants, which had successively grown and decayed, though they had not rotted, we may observe that it is always composed of thin layers, or strata, piled above each other, and the lower strata much more compressed than those above. This may be distinctly seen in many species of dried peat, and may also be observed in the face of a peat bank, or wall, from which peat had been cut. The moss plants, therefore, seem to be more analogous to wood, than to any other species of plants: they are parasitical, and can grow either upon

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wood, or upon the wrecks and particles of their own substance. But so far from being in a state of putrefaction below, they will not grow in any soil where the putrefactive fermentation is excited.

There are two species of moss, *viz.* black moss, which is of a mahogany colour in its original state, but soon becomes black by exposure to the air. Whitish, yellow, or foggy moss, is much less compact than the former, and retains a white or yellow colour after it is dried: the latter does not seem to be in such a perfect state of maceration as the former, as the fog, of which it is composed, still retains its organized form; and there does not seem to be such a great variety of the moss plants present in this species of peat, as in the black. The predisposing cause of these variations seems to be either the soil, or species of wood on which the moss at first commenced its growth, or the climate in which it is situated. Thus mosses growing on fir woods, are generally of the soft and spongy kind, and the trees themselves may be split into slices, which are used in many parts of the country in place of candles: mosses growing upon oaks, and other astringent trees, commonly produce a black and compact species of peat. Mosses in cold and elevated situations, as they grow very slowly, commonly produce a hard and compact peat. In this respect, moss resembles wood, which is always hard and compact in proportion to the coldness of the climate, or rather to the length of time it takes to grow; moss again, in low and warm situations, as it grows rapidly, is commonly soft and porous. These several causes often act separately, and often co-operate; and thus moss, considered as a soil, is found to possess the same varieties of quality which distinguish other soils.

If these observations be well founded, it would appear that moss is not a plant which grows by a law peculiar to itself, and in direct opposition to the established laws of vegetation in other cases; that it is a congeries of vegetables, of various species, which are adapted to grow in soils and situations, where the more delicate succulent plants cannot subsist; that they are mostly of the parasitical kind, and grow either upon rocks and damp clays, where they receive little from the soil, or they can grow upon other plants, or even upon the particles that are formed from their own dissolution; that the predisposing causes of the growth of moss, are dampness and astringency in the soil; that while these plants are growing at the surface, they are dissolving below, not indeed by a process at all analogous to putrefaction, but by the simple diffusion of their parts in water, where they remain without any chemical change.

2. *Analysis of Moss.*—At Swinridge Muir, August 1797, Mr. Smith and I attempted

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to analyse a small portion of Berkshire peat, which I had got from Dr. Coventry, professor of Agriculture in Edinburgh.

1. This peat was of uncommon density, approaching to pit-coal, and contained no marks of organic matter; therefore the vegetables, of which it was composed, had been completely macerated, and reduced to a pulp.

2. In some parts it exhibited the astringent taste of alum, in others of sulphate of iron.

3. Part of this peat being pounded in a mortar infused in pure warm water, and filtered, the liquor discovered slight marks of acidity by test paper.

4. Muriate of barytes, being dropped in, produced a copious precipitate, which proves that the acid was sulphuric.

5. Saccharine, or oxalic acid, carried down from another portion of the liquor a very slight precipation of lime, which proves that a portion of gypsum existed in the mass.

6. Lime water carried down a portion of magnesia, proving the existence of sulphate of magnesia, or Epsom salt; indeed this was evident from a slight efflorescence which had formed upon the peat while in my possession.

7. Purified pot-ash produced a copious precipitation of various substances.

8. Another portion of the same peat being burnt, emitted, towards the close of the operation, a sulphureous smell, and exhibited a sulphureous flame. The small particles which had been formerly washed, being also burnt, were powerfully attracted by the magnet. This demonstrated the presence of iron, and was an additional proof that one of the salts contained in the mass was sulphate of iron.

9. What was burnt in the mass left a large proportion of white ash, which, on exposure to the air for several days, acquired a rusty colour, owing to the iron.

10. On washing, filtering, and precipitating the liquor obtained from this ash, in the way already described, it appeared to contain the same salts that existed in the unburnt peat, though in much greater proportion, *viz.* sulphate of lime, of magnesia, of alumine, and of iron. These are the salts which are commonly found in beds of schistus; and since the ashes of Berkshire peat are in such high request as a manure, I apprehend that many beds of schistus, which I could point out, would answer the purpose much better. I am disposed to think that the chief benefit, so far as saline matter is concerned, arises from the sulphate of magnesia, or Epsom salt; and if beds of schistus be resorted to, those should be selected which abound most in this salt, and contain little or no alum, or sulphate of iron.

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The liquor extracted from the ashes exhibited no mark of uncombined acid; and it is probable that the acid mentioned, No. 3. which was scarcely perceptible, might be neutralized by a small portion of alkali formed in burning the peat.

The saline matter being washed off, there remained a residuum consisting of a light earth, mixed with particles of iron, which obeyed the magnet.

11. *Peat of Swinridge Muir.*—The black hard peat taken from the bottom of a moss being burnt, yielded a considerable proportion of ashes, though not such a quantity as the Berkshire peat. The ashes were of a brown colour, like rust of iron, and were attracted by the magnet.

12. Being infused in warm water, and the liquor passed through a filter, it discovered no mark of acid, or of alkali, by test paper.

13. Oxalic acid carried down a small precipitate of lime; hence the ashes contained gypsum, or sulphate of lime.

14. Muriate of barytes caused a very considerable precipitate; hence the acid that entered into the composition of the salts contained in the ashes, was the sulphuric.

15. Infusion of camomile flowers produced a dark precipitate; hence sulphate of iron.

16. After the lime was carried to the bottom by the oxalic acid, volatile alkali caused a minute precipitate of magnesia in the liquor that was left clear; hence the ashes contained a small portion of sulphate of magnesia, or Epsom salt.

It appears therefore that this peat ash contained the same saline ingredients with the former, though not in such proportion. A much greater proportion of uncombined iron was left in the residum.

17. *The Foggy, or Yellow Peat*, being burnt, did not yield so large a proportion of ashes as the former; they were white, and did not obey the magnet: a filtered solution discovered no mark either of acid, or of alkali, but was found to contain a minute portion of gypsum, or sulphate of lime. No iron could be found.

18. *Subsoil of Moss*, being examined, was found to consist of a bluish white clay. This being made into balls, and dried in the air, was afterwards burnt in a kitchen fire, where it became white, and very hard; being afterwards exposed to the air during nearly three weeks, it became rusty, shewing that it contained iron.

19. The balls being pounded in a mortar, infused in warm water, and filtered, the infusion tasted of alum; but exhibited no mark of acidity by test paper.

20. Muriate of barytes produced a very copious precipitate, proving that sulphuric acid entered into the composition of its salts.

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21. Decoction of camomile flowers produced a dark precipitate, proving that sulphate of iron existed in the liquor.

22. Oxalic acid produced no precipitate; hence no lime, nor any combination of lime, existed in this mossy subsoil.

23. Volatile alkali threw down a very slight precipitation of magnesia; hence a small portion of Epsom salt.

It appears therefore that this subsoil contained the same saline ingredients which are found in those beds of schistus called till. These are naturally the most sterile of all soils; and to distinguish them from schisti of an opposite character, I have called them the aluminous, and pyritical schisti.

It may be observed, that by these experiments we did not find what we were in quest of, *viz.* alkali, in the ashes of peat. It is possible, that pot-ash may be formed in the ashes of some species of peat, and that their effects as a manure may partly depend upon this salt, though we found none in the ashes we examined; indeed pot-ash, and the salts we actually found, could not co-exist in the same liquor.

But how happens it that peat acquires the salts already described?

On the one hand it appears that iron, magnesia, and sulphur, are evolved in the ultimate dissolution of all animal and vegetable substances, at the time when they pass into an earthy residuum. Now the Berkshire peat was evidently in this state, and resembled a petrifaction: the lime, and part of the sulphur, might have been produced by those tribes of fresh water shell-fishes, which cause shell marl in the bottoms of lakes and ponds, and are frequently afterwards covered over with moss. The various strata of schistus, and of pit-coal, seem to have been originally derived from mosses, and to have acquired their peculiar ingredients in this manner.

On the other hand, Mr. Smith assures me he has frequently found the salts in question in mosses in Scotland, but was always able to trace their origin to springs, which either burst out, and ran over part of the moss, or oozed imperceptibly from some part of its bottom. The question is left to be decided by farther investigation.

The Berkshire peat is more dense, and yields a greater proportion of ashes, than any peat I have seen in this country: perhaps its effect as a manure may depend as much upon its earthy residuum, as upon its saline matter.

Juice of Peat.—That juice of peat contains the gallic acid, or tanning principle, appears from various facts. I am told that the Highlanders use moss holes in place of tan-pits, aiding the moss water with the bark of oak, birch, willow, and mountain ash,

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and excluding all running water from getting into the pit. It is known that water, which runs through moss, is frequently employed to steep lint; but it is also known that stagnant moss water, that is, what oozes from the sides of the hole where it is collected, invests the lint with a dark skin, and prevents its putrefaction. This, by the people who live near mosses, is called *barking the lint*, and they are always careful to use water which runs through the moss from the neighbouring fields, as what oozes from the moss itself uniformly prevents, instead of promoting, putrefaction.

24. But what seems to put this matter beyond a doubt is, that the juice of moss uniformly gives a dark inky precipitate with the sulphate and other salts of iron. When the extract, or juice of moss, is much distended with water, it sometimes requires a great part of the superfluous moisture to be evaporated, in order to render this effect the more striking; but in the many trials I have made with juice of moss, in various parts of this country, I never saw the experiment fail.

Mr. Smith has suggested some phenomena, which the preceding fact may enable us to explain. In some places it may be observed, that water which oozes from the side of a moss bank, where peats have been cast, destroys every succulent vegetable that lies in its road, though it does no harm to the moss plants: this water conveys with it the gallic acid, or tanning principle, which destroys succulent vegetables, unless it be neutralized. Again, a drain, or rill of water, that passes through a moss, and which conveys water different from what it receives in its passage, causes a strong growth of succulent grass in those places where it is allowed to spread. This water soon washes away the gallic acid from the moss, and the brown feculent matter which it afterwards conveys, and deposits, is disposed to putrefaction, and promotes vegetation. Hence water that passes *through* a moss, though not that which comes *from* a moss, may be used for watering land. Hence also in converting moss into manure, it would be useful to steep it some time in a hollow, where a rill of water runs through it. Hence also, part of the effect of water brought upon moss, when it is converted into a watered meadow, may arise from its washing out the gallic acid, and disposing the moss to putrefaction.

25. Three bottles of moss water were obtained, one squeezed from peat taken out from the bottom of a moss, another from peat near the top, and the third filled from a moss hole, where peats had been cast; this juice was boiled down to a small bulk over powdered chalk, and afterwards filtered.

The oxalic acid being dropped into a portion of it, carried down a precipitation of

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lime. Hence juice of peat, or rather the gallic acid contained in it, dissolves lime; and one effect of this manure, applied to moss, is to neutralize the gallic acid which resists the putrefaction of the moss.

In very dry summers, I have frequently seen water taken from a moss hole, so situated that water was not apt to flow into it from the parts adjacent, produce a sensible effervescence with chalk, and with the mild alkalies. These facts I impute to the gallic acid, which forms a soluble compound with lime and the alkalies, but becomes insoluble with iron.

26. Small portions of moss were taken, part from the back of a furrow, part from the bottom of the furrow, part from a greater depth, and part as low down as we could reach. These several portions of moss, with all the moisture they contained, were placed in the bottom of a wooden dish; a few small pieces of dried peat, the largest not exceeding the size of a small egg, were placed here and there among the other wet parts of moss. The dried peat was of different species; some hard and brittle, which breaks with a smooth fracture; some that tears asunder like hair, owing to certain grasses, and other plants, of which it was chiefly composed.

Over the moss and peat, thus placed, a few pieces of burnt lime were laid, and as much water added, as slaked the lime. The vessel was then filled with water to the brim, and allowed to remain more than six weeks.

When examined, it was found that the water had partly evaporated, and the mass was so far consolidated, that it dropped out of the dish like a cheese. On breaking it in pieces, no remnant of the wet moss could be found, except that it had incorporated with the lime, and imparted to its lower parts, a dark colour; but the threads of the dried peat remained unchanged, though invested with lime, while the bits of brittle peat, on being broken, shewed clearly that the moisture had only penetrated a short way within the surface, forming a nucleus around the centre, which was dry as before.

Hence, in reclaiming moss, it should not be permitted to get too dry at first, or the lime will never act upon it: dried peat, like seasoned oak, resists the admission of moisture, and may remain a long time under water before it becomes wet to the centre. But it appeared that the lime, in this instance, had followed the moisture of the wet moss into every pore, and had completely destroyed its organic fibres; but as the moisture could not penetrate into the dried peat, the lime had produced no effect upon it.

27. A little of the juice that remained in the compound of lime and moss, was

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squeezed out with the hand into a glass, and afterwards filtered. I remarked, that great quantities of gas escaped during the pressure; the water passed through the filter in a very limpid state, and conveyed with it none of the colour of the moss.

A little of the filtered liquor being dropped into a solution of sulphate of iron, at first produced a brown colour, being the precipitate of iron with lime; but on the addition of more liquor, a very intense dark precipitate, resembling ink, was produced, though retaining a greenish tinge: the dark precipitate went to the bottom, while the brown remained suspended in the liquor. Lime water, being poured into ink, produced a greenish black precipitate, and left the liquor of a red colour; it produced upon it precisely the same effects that took place in this experiment; there can, therefore, be no doubt, but the dark precipitate in this case was produced by the gallic acid, or tanning principle, acting upon, and rendering the iron insoluble.

Hence it appears evident that quick lime, added to wet moss, extracts from it a much greater proportion of the gallic acid, or tanning principle, than can be obtained by pressure, or other means; for though the galate of lime, in this case, was distended with much more water than was contained in the moss, the precipitate of iron was much more copious than in any of the former cases.

28. The oxalic acid being dropped upon another portion of this filtered juice, carried down a very strong precipitate of lime, and wholly divested of that colour which accompanies precipitates of lime from moss water, to be afterwards mentioned.

After this combination of oxalic acid and lime had dropped to the bottom of the glass, the liquor discovered evident marks of acidity by test paper, and when dropped upon sulphate of iron, produced a dark precipitate as before. Here then was obtained the gallic acid in an uncombined form, of sufficient strength to act upon test paper, and proving its character by its effects upon iron.

The change of colour from a rutsy brown to black, which Lord Dundonald calls oxygenation, when peat is cut from a moss and exposed to the air, appears to me to depend upon particles of iron contained in the moss plants, acted upon by the gallic acid, or astringent juice. In the same way, when fishers prepare their nets in the juice of bark, the liquor is of a brown colour, but becomes black when the nets are exposed to the air. We may observe also, that common ink never becomes perfectly black until it has been frequently shook, and exposed to the air, sometime after it is made. Whether the iron, or the astringent juice, imbibe oxygen in these cases, we are unable to affirm; but it would seem, that exposure to the air causes the gallic acid

to unite more intimately with the iron; hence to render its particles less soluble in water, and their blackness more intense.

When every pore in the fragments of plants of which moss is composed, is thus filled with the insoluble compound of iron and gallic acid, it is evident that water cannot easily penetrate into a mass of dried peat; it may get into the internal cavities, but cannot get into the pores of the plants. Hence lime does not operate so powerfully in reducing moss that has been dried, as that which has uniformly been kept wet; because the water, which operates as the vehicle to convey the lime, cannot get into the pores of the peat.

We therefore see one great effect of lime in reclaiming moss, consists in seizing and neutralizing the gallic acid, which resists the decomposition of the moss plants. Perhaps this observation is also applicable to all soils that are covered with heath, or other astringent herbage.

29. Lime-water being added to the filtered juice of peat, changes it to a dark brown colour, and soon causes all the feculent matter of the peat to drop to the bottom of the glass, though it appeared before to be in perfect solution.

In the same way, when a sufficient quantity of lime-water is added to muddy moss-water, in which a vast quantity of mossy particles are suspended, but not dissolved, it soon causes all the moss to fall to the bottom, leaving the liquor clear. In these cases a thin pellicle of oil, resembling that which is obtained by distillation from pit-coal, rises, and floats on the surface of the liquor.

How are we to account for this fact? Lord Dundonald says that sorreline, or oxalic acid, abounds in moss; and it occurred to me that this effect might be caused by this acid, which forms an insoluble compound with lime, and precipitates it from all its solutions, even from those that are made by means of the mineral acids.

30. It was next proposed to try the effect which oxalic acid might produce upon moss-water. This acid, both prepared from sugar, and squeezed from the green leaves of sorrel, was dropped into filtered moss water, into the expressed juice of heath, and of various astringent plants; but it soon rendered these liquors perfectly limpid, throwing down at the same time, a small quantity of whitish precipitate; if, therefore, sorreline acid abounded in moss, the water which flowed from the moss would be perfectly transparent.

31. But what appeared to satisfy, that oxalic acid had no concern in this precipitate, is, that after it was washed by repeated additions of water, until all the uncombined

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lime was completely extracted, the sulphuric, nitric, and muriatic acids dissolved the lime contained in the precipitate with considerable effervescence. Distilled vinegar indeed produced no effect upon it; and perhaps none of the vegetable acids are able to decompose the compound formed, in such cases, between lime and moss. The solutions being again washed off, the oxalic acid produced a very clear and distinct precipitation of lime from each of them. The experiment was frequently repeated, with the same result.

Now the precipitate of moss, by lime-water, could not be owing to oxalic acid contained in the moss, because the mineral acids again robbed the moss of the lime with which it had combined; whereas real oxalic acid robs the mineral acids themselves of lime. The combination in this case then must have been, not between lime and any acid, but between lime and the matter of the moss itself, forming a compound, insoluble in water, and possessed of much more specific gravity, than moss in its natural state.

32. Three portions of moss, the first from a considerable depth, the second from a furrow thrown up with the spade, the third a piece of black dried peat, were digested in caustic pot-ash; at the same time similar pieces of moss were set to digest in caustic ammoniac, or volatile alkali.

These preparations being allowed to remain more than two months, the result seemed to be the same in both. The two first pieces of peat were reduced into a black pulp, soluble in water, and had swelled considerably during the progress of combination with the alkalies. The dried peat was softened on the surface, though it had resisted the penetration of the liquor into its interior parts. These being alkaline composts in miniature, it seems to result, that moss should never be allowed to get fully dry, before it is mixed up in compost with alkaline, or perhaps with putrescent manures.

33. About three-quarters of a pound of pot-ash being rendered perfectly caustic with lime, the alkaline ley was poured upon genuine wet moss, immediately after it was taken from a considerable depth; this moss was of a mahogany colour when taken out, but its surface soon became black by exposure to the air. The moss was boiled among the alkaline ley, in an iron pot, during two days and a night. The liquor swelled much, and emitted much elastic vapour, so that it was necessary to boil it very gently.

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The moss was soon reduced into a pulpy mass, and dissolved in the liquor. Being afterwards considerably diluted with water, it was passed through a searse, and left a small quantity of mossy fibres, which, being washed and dried, retained their inflammability.

The filtered liquor was now boiled down to dryness, and was found to possess all the qualities of an alkaline solution of moss, extremely soluble in water, though not deliquescent. It was black, like pitch.

34. A portion of this alkaline solution of moss being dissolved in water, and lime-water added to it, the whole of the moss was soon caried down to the bottom, leaving the liquor clear.

This clearly proves two things: first, that lime has a stronger attraction for the matter of moss than pot-ash, or indeed any of the alkalies, for it was tried with them all. In making alkaline composts with moss, therefore, I can see no propriety in what some recommend, to have a large quantity of quick lime mixed with the alkalies, to render them caustic. Such alkalies, however caustic they may be, never will combine with the moss, while lime is present to combine with it. If these alkaline composts be of any use, they should be made of alkaline ley drawn from quick lime. Second, This experiment proves that the precipitate mentioned, No. 29, and the one now under review, were really an alkaline solution of moss, insoluble in water, and indecomposable by the vegetable acids. I tried if lime would produce the same effects upon the oleaginous alkaline solutions that it exhibited upon the mossy alkaline solution, and found that it uniformly appropriated the oil, forming with it a white paint, or calcareous solution of moss, insoluble in water, while the alkali remained in the liquor in an uncombined state.

35. After the lime had carried down all the moss from the alkaline mossy solution, and had left the alkali dissolved in the clear liquor: with a view to try if it had extracted any gallic acid from the moss, the clear liquor was decanted off, and sulphate of iron, in solution, added to it; a dark precipitation ensued, mixed however with a grassy green, owing to part of the precipitate being caused by the alkali, and not wholly by the gallic acid.

This shews that pot-ash has a stronger affinity to the gallic acid than lime; for when the lime went down with the moss, the gallic acid remained combined with the pot-ash.

It also appeared evident from this experiment, as well as from No. 27, that the

alkalies and lime extract a much greater proportion of the gallic acid from the same quantity of moss, than can be procured by steeping, infusing, or pressing the same moss: or by any other methods without the application of these agents.

36. The various salts of lime, the carbonate and oxalate excepted, decompose the alkaline solution of moss by double elective attraction; for while the acid in these salts combines with the alkali, the moss is precipitated in union with the lime. Muriate of barytes, and all other earthy salts which the alkali can decompose, operate in the same manner upon the alkaline mossy solution. All the metallic salts that are decomposable by an alkali, are mutually decomposable by the alkaline mossy solution. The acid in these salts combines with the alkali in the alkaline solution of moss; while the moss combines with the metal, forming an insoluble compound: these compounds may be called calcareous, earthy, or metallic insoluble alkaline solutions of moss, according to the substance which enters into their composition. The same effects happen when these salts are applied in solution to a solution of the oleaginous alkaline solutions of moss.

It would therefore appear evident, that one great effect of adding lime to moss, is converting it into an insoluble alkaline solution of moss, of much greater density than the moss in its original state. Moss is naturally of less density than water, and is partly soluble in it. But the compound of moss and lime is of much greater density than water, and is insoluble. Moss does not allow water to filter, or to pass through it, but holds it like a sponge. The compound of lime and moss resembles friable loam, is of a dark brown colour when wet, and of a hazel colour when dry. It readily admits moisture to pass through it, and the water which flows from a moss, that has been well limed, is limpid and pure, not being charged with any of the mossy matter, as this had been rendered insoluble by its union with lime.

So great is the power of lime in reducing moss, and causing it to collapse, that I remember several years ago, Mr. Smith shewed me a moss, a great part of which had been reduced into cultivation, and well limed. What was cultivated had sunk more than three feet below the surface of what remained in its original state. This effect could not be imputed to draining alone, as the standing face of the natural moss was much more dry than the cultivated moss, which had sunk so far below it.

37. Powdered chalk being put into moss water, and into the alkaline solution of moss, and frequently stirred during several days, did not carry down one particle of the moss from the solution. From No. 25, it appears, that carbonate of lime is capable

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of neutralizing the gallic acid contained in moss, and thus may produce one good effect, viz. bringing it into a state where it is capable of undergoing the putrid fermentation; but from the experiment just recited, it appears that carbonate of lime is incapable of forming that close union with moss, by which it is speedily converted into soil.

Hence the more caustic lime is, when applied to moss, the sooner will this purpose be effected.

It appears also from the preceding experiments, that lime is a much more effectual manure for reducing moss into cultivation, than alkalies, or putrescent manures. Lime causes the moss to consolidate into an insoluble earthy compound, friable, and of proper specific gravity to sustain the roots of plants. Alkalies cause moss to swell into a larger volume than before, while they render it so soluble in water, that what has actually combined with them, is in danger of being soon washed away. However useful, therefore, it may be to apply alkaline composts of moss to other soils, it does not seem advisable to use alkalies for reducing the moss itself into a state of cultivation. The same observation seems applicable to putrescent manures: these may be applied with great effect in union with lime, or after lime has already reduced the moss into a soil; but when applied singly, in the first instance, they render the moss too blistery, enlarge its volume, and cause it to become more soluble in water than before; of course, though such manures may cause moss to throw up a luxuriant vegetation, they at the same time increase its inherent defects, want of solidity, and too great a retention of moisture, so that the moss is not able to bring to maturity the vegetables it sustains. We may also see good reasons for having all mossy composts drenched with as much water as they can hold, without running off, every time they are turned.

38. With a view to detect the nature of the matter of moss, or that principle in it, which combines with lime and alkalies, acids were added to the solution, formerly described. The sulphuric acid raised a violent effervescence, and much gas escaped; while the moss was precipitated from solution in the form of a yellowish, oily, or resinous matter. Being diluted, and passed through the filter, the coloring matter peculiar to moss water went through in a state of solution, and there remained upon the filter a brown, greasy, and inflammable matter, arranged in small flakes. It is remarkable that all the precipitates of moss from solution, either in water or alkalies, constantly assumed this flaky appearance, somewhat similar to the figure of certain moss plants. From this and similar experiments, which were frequently repeated, I am at a loss to decide to what class the matter of moss, which combines with lime

and alkalies, ought to be referred; whether to oils or resins; but it was highly inflammable. The calcareous and alkaline compounds with moss were also inflammable; though much less so than the flaky matter precipitated from them by means of acids. The same effects resulted from subjecting the calcareous compound of moss to the marine acid, and much gas escaped during the process.

39. The nitric acid acted with great violence upon the alkaline solution of moss; part combining with the alkali, and forming nitre, while part of the acid was decomposed, and went off in red fumes, both when the alkaline solution of moss was in dry powder, and when it was diluted with a portion of water. In the first case it left a brown powder, which seemed to be the moss calcined; in the last case a brown liquor was left, which being evaporated some time in a heat approaching to boiling, and set aside to cool, threw up crystals of oxalic acid.

40. That these crystals were really the oxalic acid, was proved in the following manner. A filtered solution of them being made, and dropped into lime-water, and into purified solutions of lime by means of acids, an immediate precipitation ensued; the lime being soon carried down to the bottom in union with this acid.

The moss, therefore, contains no oxalic acid in its original state (see No. 31); it seems to contain the basis of this acid; and the only question is, what this basis may be.

Fourcroy says, that nitric acid, added to the gallic acid, produces the oxalic acid.

41. To ascertain this, I added nitric acid to a highly concentrated decoction of camomile flowers; a plant known to abound in the astringent principle, or gallic acid. The result was oxalic acid, which carried down lime from lime water, and from solution by means of other acids.

From these facts it should follow, that when putrefaction is excited in moss, or in mossy composts, by means of the ashes left after burning, by means of alkalies, or of putrescent manures, without the presence of lime, as the salts which operated in these cases to excite the putrefaction are soon washed away, or form new compounds, a portion of nitric acid should be generated from the nitrogen, which is evolved, forming an union with oxygen; that this nitric acid, so formed, uniting with the gallic acid in the soil, must produce oxalic acid, and thus dispose the moss, or mossy compost, to encourage the growth of sorrel; that part of this effect may doubtless be imputed to the puffy state to which such manures reduce mossy soils, and mossy composts, thereby rendering them more liable to be acted upon by the oxygen of the atmosphere,

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while they become more retentive of moisture to aid putrefaction; that the texture of a soil, as well as its ingredients, renders it a more fit receptacle for some species of plants than others; but where lime is applied, the texture of such a soil or compost is rendered much more solid, and permeable to water, while oxalic acid in moss, manured by lime, cannot encourage the growth of sorrel, as this acid forms with lime an insoluble compound, increasing the density of the soil, a compound not to be destroyed by any other solvent of lime; though, therefore, oxalic acid should be formed in moss manured with lime, or in calcareous composts of moss, it is plain it cannot encourage the growth of sorrel.

Though these inferences are deduced merely from the preceding experiments, they correspond with practical observations.

Mr. Smith remarks, and indeed has demonstrated the fact by the most satisfactory experiments, that all limed mosses, and mossy composts in which lime is used, constantly throw up chickweed, or arsewort (a vegetable only to be found in putrid soils divested of astringency) after the lime has produced its effect; but all mosses that are burnt, and those which are manured with dung or alkalies, and all mossy composts that are formed with alkalies and putrescent manures, without the intervention of lime, constantly throw up the sorreline plant, and yarr.

He has a field of deep moss, part of which was dressed with lime, part with stable dung alone, part with dung and lime united, and these were applied in different proportions to different parts of the field. Part of it was pared and burnt in the usual manner, and to some parts of this last, lime was also applied.

When I saw the field several years ago, some time after it was thrown into pasture, the limed parts were easily distinguishable by a close sward of sweet herbage, in which white clover predominated; and it was easy to discriminate those parts which had received a large proportion of lime from those which had got a smaller dose, by the superior closeness and richness of the herbage. Those parts which had got both lime and dung, carried a ranker herbage than those which had got lime only, though of the same quality with the former. The parts which had got nothing but dung, and those which had been pared and burnt, appeared puffy and blistery, and carried only a tuft of grass here and there; but there were innumerable tufts, or rather patches, of sorrel, and in some places this plant occupied the whole surface. Now this field was never sown with grass seeds; but was left to gather such plants as nature might produce.

At present after laying more than seven years, the limed parts are covered with a

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rich close sward of natural grasses, abounding with white clover, and never were observed to throw up one sorreline plant, while the dunged and burnt parts are almost wholly occupied with heath, which has lately induced Mr. Smith to top-dress these parts with lime.

If the inferences drawn from the preceding experiments be fairly deduced, it would appear that the putrefactive fermentation in these parts had ceased; of course the astringent plants have resumed their ancient empire. Such plants never grow where putrefaction is going on in mosses, or where lime is present.

From a review of the preceding experiments it appears,

1st. That lime is the most powerful agent that can be employed for reducing moss into soil.

2d. That quick lime is much more powerful than its carbonate in neutralizing the styptic juice of moss, because, being soluble in water, it insinuates itself through every pore of the plants; and while one part combines with the gallic acid, or styptic juice, the remainder unites with the mossy matter itself, forming it into an insoluble alkaline solution of moss, or soil of great fertility.

3d. That during the action of lime and alkalies on moss, gasses are generated. From No. 26. it would seem that these gasses are not chemically combined with the moss, but, like the carbonic acid in yeast, are separable by pressure, or agitation, and hence part of them at least remain in an active state, ready to promote the growth of plants. Indeed the same conclusion was inferred from examining the alkaline solution of moss, though in a much higher degree.

4th. It appears that alkalies are much better calculated than lime to dissolve the moss plants, and to generate gasses in them beneficial to vegetation; but as they render the moss very soluble, and enlarge its volume, they produce no soil capable of sustaining the plants. The same observation is also applicable in part, to putrescent manures.

5th. I had intended to have collected and ascertained the nature of the gasses generated in the cases already mentioned, and to have followed out these inquires through soils of every species, from the point of absolute sterility to that of the highest fertility—*Sed non omnia possumus omnes.*

Though agriculture has attained a considerable degree of improvement from random efforts, unassisted by science, yet it is to science alone she must look for her highest improvements. To this, as to every other subject, the maxim will apply,

Felix qui potuit rerum cognoscere causas.

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6th. Reasons will appear why mosses and other soils, in given circumstances, are more apt to produce one species of plants than others.

7th. What is here detailed concerning the action of lime and of alkalies upon mosses, together with that of putrescent manures, is also applicable to the action of these substances upon other soils, in so far as they act upon vegetable matters. From the slight sketch of facts here enumerated, a stupendous theory might be reared; but what avails it to pile volume upon volume, conjecture upon conjecture!—One fact is worth them all; and in an experimental science like agriculture, we ought not to reason from one or a few facts, but should have them all clearly ascertained, and distinctly arranged, before we attempt to draw general conclusions.

8th. I cannot dismiss this article without suggesting my admiration at the beneficence of Providence, in having provided the moss plants for the situations in which they grow: they afford an immediate supply of fuel; are the source from which pit-coal derives its origin, though trees, and all the plants which abound in oils and carbon, also contribute to the supply of pit-coal. Were the places now occupied by mosses divested of vegetables, or stored with vegetables of a different character, they would become noisome fens, which, by the emission of putrid gasses, would spread all around them pestilence and death. Mosses emit no noxious gasses: but rather, by growing at the surface, where the plants are acted upon by the sun's rays, they perpetually throw out oxygen, and thus contribute to the salubrity of the atmosphere. The only defect with which they are chargeable is forming magazines of moisture, which by its exhalation generates cold, and spreads rheumatism and intermitting fevers among all the animals within its reach. The perpetual evaporation of this moisture not only tends to chill the moss, but it descends into hoar frost, and mildews, upon all the lands that are lower in point of situation. These last-mentioned disadvantages are more than amply compensated by the consideration, that moss is not only an inexhaustible magazine of manure for other soils, but may be converted into a most fertile soil itself. After it is so converted, none of the defects already stated are any longer applicable to it.

Of Floating Moss.—Mosses were formerly considered as applicable solely to the purposes of fuel, until the late Lord Kaims first set on foot a project for floating away an extensive moss on his estate near Stirling. The project has been followed to a much greater extent by his son, who has constructed a bucket wheel of great power for raising water out of the Teath, to float the moss: the water is raised somewhat higher than the top of the moss, passes some hundred yards in hooped wooden pipes

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of 18 inches diameter under ground, and then emerges upon a raised embankment of earth, by which it is conveyed to the moss. For a particular account of this improvement the reader is referred to the Agricultural Survey of Perthshire, by the Reverend Dr. Robertson. He states the expence of this machine and embankment at £1000. but the people with whom I conversed upon the spot, told me it cost £1500. When the water arrives at the highest part of the moss, it is conveyed in a rut perpetually descending, along the whole line of the uncleared moss; at every part of this line, the people were employed in throwing the moss into the stream with spades. Those at the part where the water first enters the moss, keep the stream upon the surface, and they lift and throw into it all the moss within their reach, until they uncover the clay below; they then cut out a new water-course, and throw into it the embankment of moss which sustained the water before; those lower down operate in the same way, only they preserve the current of water on a lower level than those above them; those at the lowest part keep the water running upon the clay, and shift its course occasionally, so as to have it running along the bank, or face, of uncleared moss; thus, at every point along this water-course, people may be employed in heaving in pieces of moss by the spade, and they constantly shift the position of the stream, in proportion as the moss is cleared away.

When I was there about three years ago, I learnt that it required the labour of a man nearly a whole year to clear one Scotch acre of moss, and reduce it into a condition to receive a crop. This labour cannot be estimated as less than £25; to this add the price of seed, compound interest upon the original erection of the machine and embankment, &c. and the expence of this mode of cultivation will not appear trifling.

The soil, after the moss is carried away, being a rich coarse clay, mixed in many places with sea shells, is first formed into ridges by the spade, and commonly yields a few good crops; laying it up in drills, during the first winter, by the spade, is found powerfully to increase its fertility. When it begins to lose its fertility, it receives a good dose of lime, and is afterwards manured with peat ashes, and such putrescent manures as are accumulated on the spot.

I have heard that the farmers upon the banks of the Forth raised, at first, a great clamour against the late Lord Kaims for washing his moss into the river, because, when it was met by the tide, it was thrown out, and covered up their grass lands upon the banks; but I was told, that they afterwards became very earnest to collect what

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he had thrown away; for the moss being washed and flatted in this manner, is robbed of its styptic juice, and disposed to putrefaction; it therefore makes excellent manure for coarse lands, more especially if made into compost with lime and stable dung.

It is evident that the whole of the plain, extending from Borrostowness to Gartmore, had once been covered by the sea; and the soil is composed of clay washed down by the Forth from the mountains of micaceous schistus, where that river derives its origin. This washed clay had gradually filled up, and towards Queensferry is perpetually filling up, the bed of the sea: the carse clay is here and there intersected by sand and gravel, and other friable soils (called here, dry-field land), which have been washed down by the various streams that run into the Forth, and partake of the quality of the mountains from which they have been washed; but the mere filling up of the bed of the sea would never cause dry land to rise above its surface, and would only raise the water to a higher level. Any one who examines the plain of the Forth from its origin to its termination, and indeed any part of our island that is near the sea, must be convinced that the sea has retreated into a lower level, by at least 40 feet than it formerly occupied; and that too, since the solid land was placed in its present position. This accounts for the mud formerly deposited in this arm of the sea now appearing solid land, through which the Forth performs his whimsical meanders.

But what chiefly deserves the attention of those who have an interest is, that many parts of this carse clay are filled with oysters and other sea shells; I have observed them in many ditches, and frequently upon the surface. In some parts where a deep rut is cut by a rivulet, may be seen a deep bed of shells, which, taken in mass, is as rich in calcareous matter as the generality of limestone, and may be regarded as the material from which a future rock of limestone is to be consolidated. It is easy to select these shells from the mud, and then they would be much richer than any limestone.

Now lime is essentially necessary for this species of soil, and is, in many places difficult to be procured, on account of the distance from which it must be carried, and the badness of the roads. It would be very easy to supply its place, by burning the shells which here and there abound. Digging them would be much less expensive than quarrying limestone, and a slight heat would reduce them into very pure lime.

Dr. Robertson calculates that there may be about 10,000 acres of moss in the upper part of this plain. There are also very extensive mosses in the lower part of it, all

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upon a low level, no where exceeding 20 feet above the level of the sea at high water. Now I conceive it would be more profitable to search for these shells, burn them into lime by means of peats, and employ them in the cultivation of the mosses themselves, instead of being at the expence of floating them away. Beside these dead shells, left by the sea, the Forth and Teath abound in fresh water muscles. These might easily be bruised by a stone rolling on its edge, and being mixed with moss or earth, would afford an ample supply not only of calcareous, but also of putrescent manure. They ought to be completely rotted before they are applied, and distended with a large proportion of earth. The banks of the Teath, opposite to Blair Drummond (if a distant view can be relied on) seem to abound in clay marl. This would make an excellent dressing for the moss, after it is thrown into pasture.

But the mosses here have one advantage which seldom occurs, and which may have been the inducement to adopt this method. The soil, when got at, is excellent, being a rich carse clay, in many parts resting upon, or mixed with, sea-shells. In most other places the bottom of mosses is either a solid rock, or a whitish granite, or pyritical gravel, or pyritical and aluminous clay. After removing the moss from such places, they are worse than before, as the bottom either does not admit of culture, or would require an expence that would far exceed its value.

4. *Mr. Smith's Method of converting Moss into Soil.*—The celebrated Rabelais threw out a remark, which has been repeated by Dean Swift and others, "That the man who caused two stalks of corn, or two piles of grass, to grow where only one grew before, is a greater benefactor to mankind than all the philosophers, poets, orators, and politicians that ever existed;" but what must we think of the man who has caused luxuriant crops, both of corn and grass, to grow on those places where neither the one nor the other grew before? on places which seemed doomed to eternal dampness and sterility; from which the eye even of the enthusiastic cultivator turned with horror and despair. This has been effectually accomplished by John Smith, Esq. of Swinridge Muir, near Reith, Ayrshire; and I cannot omit this opportunity of testifying my gratitude for the long friendship with which he has honoured me, and the high opinion I entertain of his talents, and goodness of heart. Most of the experiments here recorded were made at his house, under his direction; and the greatest part of the ideas in this part of the work are his, not mine.

This gentleman, with a modesty which ever distinguishes true genius, does not even claim any merit from the first invention of this new mode of cultivation, any farther

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than having first observed, and excited others to practise it. Being in the army during the American war, where he served with reputation, he had occasionally read treatises tending to shew the advantage of cultivating moss by burning. A great part of his estate was occupied by mosses, which seemed to set all improvement at defiance. He left instructions with his curators, and also wrote them from Jersey, where his regiment was then stationed, requesting them to pare and burn a certain portion of moss every season, and directing them how to proceed. He presumed that if his tenants were once satisfied of the benefit arising from this practice, they would be induced to imitate, and thus his estate would be gradually brought into a productive condition. His curators began upon a patch of moss at the bottom of a field in his own farm, which they were then liming with a view to a crop; but having turned up the moss agreeably to their instructions, they found the season too wet to admit of burning the whole; and after much labour, they only succeeded in burning a few patches. It so happened, however, that a cart or two of lime, that was spreading on the solid part of the field, had got into the mossy part, and mired. This induced them to spread the lime where it was, in order to relieve the carts, contrary to the universal opinion at that time in that country, which was, that lime would effectually destroy moss, and render it unproductive for ever. From the influence of this opinion, the farmers carefully avoided letting any lime fall upon patches of moss which lay among their solid land, lest they might destroy any coarse herbage they occasionally yielded to their cattle. After this patch of moss had been so treated, it was all sown with oats along with the rest of the field.

Mr. Smith returned from the army the ensuing summer, and was surprised to find as good a crop upon the limed part of his moss, as upon the rest of the field. The part that had been burnt also carried a tolerable crop, though it was almost choked with sorrel. Upon the parts that had got no lime, nothing grew. He caused the whole to be laid in ridges with the spade, and limed the whole. The crop of next year was better than any in the field. Meanwhile he set one of his tenants to work to reclaim an ugly bog on a part of his farm, in which cows and other animals were perpetually miring, and which had occasioned considerable loss. Mr. Smith let off the water, and undertook to guarantee the farmer against any loss he might sustain the first year; but instead of loss, the tenant reaped a profit, and proceeded eagerly to the cultivation of other mosses in his possession.

I remember when I first went to Ayrshire, and got acquained with Mr. Smith, he

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was universally laughed at as a person deranged. I was frequently warned not to associate with him, least I might incur the same suspicion. But Mr. Smith is not apt to be baffled by first failures; and in the cultivation of moss, he has constantly improved upon the mistakes that were at first committed.

Having reclaimed all those portions of moss which were in his own possession, and satisfied his tenants of the advantage to be derived from this practice, he allowed them to dig as much limestone as they pleased, and gave them the refuse of his coal, at the out-put expence, to burn it. They proceeded with great ardour under his direction, and have persevered in reducing new portions of moss into cultivation every year, until their leases are almost expired. There is now no more moss remaining unreclaimed upon the estate of Swinridge Muir, except a small patch, and that has been omitted, from want of hands. It is certainly much in favour of this mode of cultivation, that it has not been merely the random experiment of a gentleman for his amusement, but has been eagerly executed by practical farmers, who bad no other means of subsistence.

Though the people here at first laughed, and then could hardly believe their eyes, when they saw the effects produced by cultivating mosses, they were at last convinced, and were excited to imitate what they saw. There are now innumerable patches, and very many extensive tracts of moss, in this and the neighbouring parishes, carrying luxuriant crops, where I used to see nothing but miserable peat stacks, or receptacles for wild ducks and snipes. In the whole of my journey from Edinburgh to Ayrshire, August, 1797, I saw no crops so luxuriant as those, in general, were upon the cultivated mosses. In perambulating this district, I was frequently at a loss to distinguish the cultivated mosses from other lands, but seldom went wrong when I took those parts for moss where I saw the best crops. The uncommon wetness of this season, especially during autumn, has done much injury to the crops in general, but the moss crops have suffered much less than those on solid land.

Though the improvement of moss spread very slowly at first, it now advances with a rapid pace. The country owes much to Mr. Smith for his unwearied zeal in this new species of propagand. He goes about preaching this practice to proprietors and tenants with all the zeal of a missionary; he invites them to examine his operations with their own eyes; furnishes them with written directions, and with workmen, though at the expence of raising their wages upon himself and his tenants. When any thing

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goes wrong, he is ever ready to fly to the most distant corner to put them right. Over all this county, the farmers and proprietors are busy in reclaiming moss. In Renfrew, Lanark, and Dumfries shires, this practice has made considerable progress. Major Marjoribanks and Mr. Pitlow have got workmen from Ayrshire, and have commenced moss improvements, upon a very extensive scale, in the neighbourhood of Bathgate. The culture of moss has become, in many cases, a distinct species of farming, to which individuals apply, to the neglect of every other pursuit.

What may assist the inexperienced to form some idea of the value put upon moss by those who are acquainted with it, is, that a young man, son of a farmer on the estate of Swinridge Muir, has taken 20 acres of moss from William Patrick, Esq. of Trehorn, writer to the signet in Edinburgh, for four crops, at 25*s.* per acre of yearly rent. All that was done by the proprietor, was to dig the master drains, which also serve the purpose of fences; in other respects the moss was delivered in its wild and unsubdued state, the tenant being at all the expence of working and manures, and obliging himself to lime, at the rate of 10 Ayrshire chalders per acre. The moss was in crop, 1797, for the first time. I was several times upon it, and remarked, that where the lime had been early enough applied, which was the case with the greatest part of it, the crop (oats) was uncommonly good; even the worst was much better than some contiguous land which had been torn from Muir, and limed. On a small corner which had got no lime, nothing grew. The proprietor himself expected no such rent, had it not been voluntarily offered by the tenant. The solid land there, which has been long in cultivation, does not average 20*s.* of rent, as the situation is not very accessible.

Two small patches of cultivated moss, contiguous to the town of Beith, were lately set at the rate, the one of £10. per acre per annum, for two crops of potatoes; the other let for £7. per acre for two crops of oats, to be sown down with grass seeds. The first of these patches had been constantly in potatoes ever since it was reduced to cultivation, and the occupants were to furnish what dung they chose for their crops, at their own expence. The second patch, of more than three acres, had been constantly either in potatoes, or oats, from the time of its first subjugation, and would have given much more, had potatoes been permitted; but it was thought advisable to bring it into grass. It must be admitted that land, immediately contiguous to a town, fetches a rent for conveniency, as well as for what it actually produces; at the same time it

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must be observed, that the best solid land, to which these patches of moss belonged, and some of which had been long in pasture, brought only a rent of from £3. to £6. for two years crops, the whole being let in parcels by public auction.

In perambulating the different parts of Ayrshire, I perceived considerable variations in the practice of moss improvers, induced by different circumstances. Those who have large tracts of moss, and who are remote from markets, cannot afford to have so great a proportion in potatoes as those who have only a small patch. They go over as much land as they can with lime, not having dung for the whole. They take crops of oats until the land gets foul, and then leave it to gather grass as it can. Such land never being cleaned, abounds in weeds among the natural pasture. Others, who have a small patch of moss, from four to six acres, have always a part of it in potatoes with dung occasionally; another part in barley or oats, and another in cut grass. Many of these farmers never apply the plough to their mosses; for, though this may be done with safety, they say they have at least a third more crop with the spade than with the plough. After the moss is completely reduced, it is turned over with great ease, and they apply themselves to this work at intervals, either when the weather is so wet, or other circumstances occur, that they cannot work with their horses. As no plant yet tried, contributes more to the improvement of moss than the potatoe, and as it also affords an opportunity of cleaning the land, those portions of moss on which it has been frequently repeated, are clean and fertile. In a word, some of the best land I saw in Ayrshire is moss of unknown depth.

The species of crops which have been constantly tried upon the mosses in Ayrshire are potatoes and early oats; these are the crops which are most common in this country, for the people have never been nice in aiming at variety of crops: the dairy, and the breed of their cows, in which they certainly excel, being the principal objects of their attention. I have seen several excellent crops of barley upon moss, after potatoes; I have also observed that beans thrive well upon moss. Cabbages, coleworts, and turnips, have been tried, and found to thrive; and the only objection to their being cultivated to a great extent is, the difficulty of getting them off the land during winter. I saw at Swinridge Muir, on an exposed situation, a patch of the best wheat that occurred on my whole journey from Edinburgh: it had been pointed in, with the spade, to prevent it from being thrown out during winter upon moss after potatoes. Its only fault was being rater late, as it seems the seed was not procured until far in December. Much wheat was lodged, 1797, but this stood to the last. I doubt not

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but moss, after it is fully reclaimed, would make an excellent soil for hemp, for lint, and for any other useful plant.

1. When they enter upon the improvement of a moss in its natural state, the first thing to be done is to mark out and cut main, or master drains, eight feet in width by four and a half in depth, and declining to two and a half at bottom; these cost 1*s.* per fall of six Scotch ells. In some instances it will be found necessary to cut these drains much deeper, consequently at a greater expence. These drains almost in every instance can, and are so conducted as to divide the field into regular and proper inclosures. They always make it a rule to finish off as much of a drain, as they have broken up before they leave it at night, because if a part is left dug, suppose half way, the oozing of water from the sides would render the bottom so soft, that they could neither stand upon it nor lift it with the spade. When the moss is so very soft that the pressure of what is thrown out of the drain may cause its sides to fall in again, they throw the clods from the drain a considerable way back, and sometimes have a man to throw them still farther back, by a spade or the hand; for this reason too, they always throw the stuff taken from a drain, as equally as possible on each side of it. In digging the drains, the workmen stand upon small boards, to prevent them from sinking, and move them forward as the work advances.

When the moss lies in a hollow, with only one outlet, it is necessary to lead up a drain, so as to let the water pass this outlet, and then conduct it along the lowest, or wettest part of the moss; this middle drain is afterwards sloped, and the stuff thrown back into the hollows that may occur; upon it, the ridges are made to terminate on each side, while a ring-drain, serving the purpose of a fence, is thrown round the moss at the line where the rising ground commences. This can generally be so managed as to divide the moss into a square field, leaving straight lines for the sides of the contiguous fields. The ring-drain intercepts the surface water from the higher grounds, and conducts it into the lower part of the oulet, while the sloped drain in the centre receives and discharges all the water that falls upon the moss.

After the moss collapses, in consequence of liming and culture, it is often necessary to clean out these drains a second time, and to dig them to a greater depth: their sides become at last like a wall of peat, which few animals will venture to pass.

2. The drains being thus completed, they mark out the ridges, either with a long string, or with three poles set in a line. Mr. Smith has tried several breadths of ridges, but now gives a decided preference to those that are seven yards in breadth. The

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ridges are formed with the spade in the following manner: in the centre of each intended ridge a space of about two feet is allowed to remain untouched; on each side of that space a furrow is opened, which is turned over so as completely to cover that space, like what is called *veering*, or *feering*, of a gathered ridge; the work, thus begun, is continued by cutting furrows with the spade, and turning them over, from end to end, of the ridge on each side, until they arrive at the division furrows. The breadth of the slices thus cut may be about 12 inches, and each piece is made as long as it may suit to turn over: the ridge, when finished, has the appearance of having been done with a plough. The division furrow is two feet in breadth, which, if necessary to draw off superfluous water, is partly cut out and thrown upon the sides, or into hollows in the ridges on each side. The depth of the division furrows is regulated by circumstances, so as not to lay the ridges at first too dry, but at the same time to bleed, as it were, the moss, and conduct the superfluous water into the master drains.

3. The next operation is to top-dress the ridges with lime. The sooner this is done after the ridges are formed, the better. When the moss appears dry, experienced farmers throw on the lime, but do not clean out the division furrows until the ensuing winter. When it is soaked in water, they clean the division furrows as soon as the lime is ready, and after the water has run off, apply the lime immediately. It is of great importance to have the lime applied while the moss is still moist, and the lime, in as caustic a state as possible (see experiments 26. 29. 32. 37. &c.) For this purpose they have the lime conveyed from the kiln in parcels, slaked, and laid on as fast as the ridges are formed. Being dropped from carts, and slaked at the nearest accessible station, it is carried to the moss, by two men on light handbarrows, having a hopper and bottom of thin boards, and there spread by shovels as equally as possible. During the first and second years, the crop is generally carried off in the same way. In some places, where a moss is covered with coarse herbage, and accessible by carts in dry weather, I saw them give a good dose of lime to the moss before it was turned up with the spade, and another after the ridges were formed. It is surprising how quickly they execute these operations with the handbarrows. In other places, where coarse boards can be procured, they lay a line of them along the crown of a ridge, and convey the lime upon them in wheelbarrows.

The proportion of lime allowed to the acre is various, being from three to eight chalders. Improvers are much less sparing of this ingredient now than formerly, and much greater proportions have been applied with good effect. Suppose 120 bolls,

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or 480 Winchester bushels, of slaked or powdered lime, allowed to every Scotch acre; this would cost at the sale kilns 40s. and thus the reader may be enabled to calculate the expence of lime per acre in this district, at every given proportion: but most of the farmers here burn lime for themselves in vast kilns of sod, and think they have it much cheaper than it could be got from a sale kiln. In many places limestone abounds so much, that houses, fences, roads, are constructed with it; and when a farmer burns the limestone within his premises, he at least saves the expence of carriage.

In some cases, after the lime is laid on, they go over the ground with hoes, or with spades, hacking and mangling the clods, and mixing the lime more completely with the superficial soil; but where there is much to do, and hands are scarce, they seldom think of these operations.

4. The field, thus prepared, is ready to receive the seed, which is sown at the proper season, whether it be *wet* or *dry*, and harrowed in, with a small harrow drawn by two men. Four men will, with ease, harrow at least five or six roods per day, two and two dragging the harrow by turns, and two breaking and dividing the mould with spades. When the lime has been applied early the preceding summer, a good crops of oats may generally be expected; but if it has been recently applied, the first crop of oats frequently misgives, as the lime has not time to combine with the moss, and form it into a soil.

The early white Dutch or Polish oats are always preferred by moss improvers, as the common Scotch, or late oats, are too apt to run into straw, and lodge, before the grain arrives at maturity. The same proportion of seed is allowed per acre that is usual in other places.

Mr. Smith, in searching some old records, found an old tiend valuation, by authority of the high commission court, of the greater part of the tiends of the parish of Dalry, by which it appears, that the only grain then raised in the parish was grey oats, estimated at half meal; and that crops of this grain were produced in elevated situations, where no grain has been attempted in the memory of man; this grain is known to thrive in very poor soils, throws up a great quantity of straw, though it produces only half meal; he has, therefore, made application to some of his friends in the Highlands to procure some seed of that species for moss grounds, the first year, where the lime has been but recently applied. The value of the grain being out of the question, he thinks the straw may prove useful to cattle; and by growing more luxuriantly

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than other oats, it may serve to keep the surface moist, and shelter it from the summer's sun, an object of great importance to promote the action of lime upon moss.

He is also about to try the experiment of sowing Russian or winter rye, on moss where the lime has been recently applied. This is known to be a very hardy grain, and to thrive upon poor soils. The great desideratum is to procure plants which will throw up a sufficient quantity of herbage so as to shield the surface from the winds and sun's rays, and thus to keep it moist during the first summer after a moss is reclaimed.

This desideratum is effectually supplied by the potatoe, which thrives well on moss at all times, whether recently opened up and limed, or at any future period of its cultivation, only it requires a proportion of stable dung. It is now become the general practice in Ayrshire, to plant potatoes on those mosses which have been but recently turned up and limed; and where dung can be procured, it is generally the first crop on all their mosses.

The method of planting potatoes, whether they be the first crop, or succeed the first crop of oats, is by lazy beds. If they be the first crop, the moss having been delved into ridges, and limed as before directed, spaces of from five to six feet in breadth are marked out across the ridges, having intervals of about two feet, from which the moss is taken to cover the sets: these spaces, or beds, are covered over with a thin stratum of dung, laid upon the surface of the lime, at the rate of about 16 tons to the Scotch acre: the cuttings of the potatoes are laid, or placed upon the said beds, about 10 or 12 inches asunder, and the whole are covered over with moss taken from the intervals, which are thus converted into ditches, to be followed by another covering about the time the potatoe plants begin to make their appearance, the covering in the whole amounting to about four or five inches; at the same time the division furrows are cleaned out to cover the sets that are contiguous to them. The whole field is thus divided into spaces, or lazy beds, like a chequered board. During summer they cut the moss with hoes, and draw it up a little towards the stems of the plants. Few weeds appear, except what are conveyed by the dung. This is the practice universally followed when potatoes are planted on moss for the first time; but after the moss is finely pulverized and reduced, they either plant them in rows across the ridges, or plant and dress them with the plough, in the usual manner.

Potatoes planted as the first crop, never misgive, and they are the best and most certain method at once to reclaim a moss, not owing so much, perhaps, to the dung aiding the putrid fermentation which the lime has already excited, as to their roots pushing

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and dividing the moss, while their leaves shelter it from the sun, cause a stagnation of air, and thus keep it in that degree of moisture which is most favourable to the action of lime upon moss. The practice of making potatoes the first crop is now universally followed, in so far as the farmers can command dung. The produce is from 40 to 60 bolls per acre, the potatoe measure being eight Winchester bushels, a little heaped, to the boll. Mosses that are fully reclaimed yield from 60 to 70 bolls of potatoes at an average, and in some places, where manures are abundant, they have been known to yield from 80 to 100 bolls per acre, of the above measure.

Mr. Smith is about to try yams upon his mosses, from the opinion that prevails among some of the Mid Lothian farmers, where this plant is much cultivated, that they require little or no dung; and that the superior breadth of their leaves will prove more favourable, than even those of potatoes, for sheltering the ground.

When the potatoe crop is removed, the ridges are again put into their original form, in doing which, care is taken to preserve the mould that is acquired uppermost; this is done by moving the sub-furrow on each side with a strong spade, half way into the intermediate ditch from which the lazy beds were covered, and scattering the mould equally over the whole surface. This operation costs 18*s.* per acre. It is not easy to calculate the expence of planting the potatoes, forming the lazy beds, &c. as this is seldom executed by contract; but the lazy beds being thus reduced, the land is ready for a crop of corn.

Though a crop of oats frequently misgives upon moss that has been but recently limed, yet in other cases, when the lime has lain several months upon the land, it proves a good crop, and is sufficient to cover all the expence, with a little profit. The crops of succeeding years are sufficient to afford from their straw putrescent manure for such land, in order that it may be cleaned with potatoes, and prepared for grass seeds.

But after potatoes of the first year, with the slight operation of reducing the lazy beds, from 10 to 12 bolls of oats are, at an average, produced per acre. The oats are excellent, and yield from 18 to 20 pecks of meal per boll; they would sell upon the ground for £10. or £12. per acre. The ground continues to yield oats of the same quality for several years, without any apparent diminution of fertility, and without receiving any additional manure: the only apparent bar to the continuance of this crop, is the soil becoming grassy. When the grass begins to contend with the crop for pre-eminence, the land is thrown into pasture, and would let, ever after, in that state, at from

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20*s.* to 25*s.* per acre. Daises, white clover, &c. &c. now spring up in mosses where their existence was never before suspected; at the same time thistles and other weeds, for some time, infest the pasture.

The better practice is to take another crop of potatoes, with a little dung and lime, and give it a trench delving to bury the weeds, and bring up new soil; after the potatoes, to sow barley and grass seeds.

Rye-grass is universally sown here, and it attains amazing perfection upon moss properly prepared; along with this, white and yellow clover are sometimes sown, and thrive remarkably well. Red clover has been tried, but did not succeed, and is hence discredited, for moss lands: perhaps it may have been unjustly censured, because it is certain that the seasons in which it was tried proved very unfavourable to red clover in all parts of the country, most of it having died during winter.

5. We have already described the levelling of the lazy beds. All future delvings of the moss are performed from one end of the ridge to the other; by this method the slices that had been cut, and turned over in the first operation of forming the ridge, are again cut across, and constantly reduced into smaller pieces, until they moulder into earth.

The expence of delving a moss for the first time, where the surface is tolerably smooth, is $2\frac{1}{2}$*d.* per fall, or £1. 13*s.* 4*d* per Scotch acre; but where inequalities occur, which must be thrown by the spade into hollows, it costs about £2. per acre. If there be eminences which must be removed into hollows, by wheelbarrows running upon boards, the first expence is greater, according to circumstances. The second delving, where potatoes have not intervened, costs from £1. to £1. 6*s.* per Scotch acre, the division furrows being at the same time cleaned out. The third delving, and cleaning of the division furrows, cost £1. per acre; but the moss is now so friable that it may be wrought with the greatest ease and rapidity. At the above rates, an ordinary workman will earn 1*s.* 6*d.* per day; and an able and experienced one, from that to 2*s.* 6*d.* per day. They use a strong spade edged with steel, and have always a grit-stone near them, for sharpening the spade. In the evenings they repair its edge upon a grindstone, and when the steel is worn away, they lay it again with new steel. Sometimes the moss is so soft, that they walk upon boards while they are turning it over.

Mr. Smith has found by long experience, that it is improper to make the ridges too high, or too narrow: when they are made too high, they throw the water off from their sides, without admitting it to penetrate their substance; the top of course gets

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too dry: when too narrow there is a loss of surface from too many division furrows; the breadth already mentioned is found to be the best: and when the improvement is completed, the ridges appear like segments of wide circles, with a clean well defined division furrow between each of them. The moisture is thus caused slowly to filtrate through the moss, rendered friable by lime, until it reaches the division furrows, and is discharged. As the moss subsides for some time, and closes in towards the furrows, it is generally necessary to clean these out before winter, and at the time the crop is sown, until the moss acquires solidity.

Some mosses may be ploughed, the second year, to within two bouts, or fur slices, of the division furrows; and every operation performed by the force of horses, except turning over with the spade, the narrow stripes next to the division furrows. In other mosses it requires three years before this can be done; and it seldom happens but every moss may be wrought wholly by the plough, after it has been wrought four years by the spade. When moss is wrought by the spade, it seems to be of no consequence whether it be wrought wet or dry; but when it is wrought by the plough, opportunities must be watched, as horses cannot walk upon it, for some years, during wet weather.

6. With respect to the quality of the potatoes thus produced upon mosses, I do not scruple to pronounce it most excellent. Potatoes have been tried with dung alone, but they were always watery, and frequently hollow, or rotten, in the heart: those raised upon mosses that have been well limed, are frequently so dry and farinaceous, that it is difficult to boil them without reducing them to powder; and they are often obliged to lift them with spoons: they come clean out of the ground, keep remarkably well in heaps covered over with moss in the field, and are remarkably well flavoured.

No such disease as the curl was ever known among moss potatoes; and indeed if Dr. Coventry's opinion be true, that the curl is caused by overloading the sets with too much earth, or from the earth becoming too hard around them, no such thing can take place in moss; but to whatever cause the curl may be owing, it is certainly propagated by diseased seed; it would therefore appear advantageous to transfer the potatoes raised upon moss, as seed for solid land. They have a remarkably good species of potatoe in this district, which was brought from Virginia to Largs, about eight years ago; and whether it be owing to the beneficial nature of a mossy soil, or to its own intrinsic merits, this potatoe has long been so much distinguished by the good quality, and large quantity of its produce, that it has superseded the use of every other species. There seems to be no occasion for moss improvers to change their seed. Some

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persons in this district, who have but small patches of moss, have kept them constantly in potatoes, more than ten years, without changing the seed, and that without any sensible diminution either in the quantity or quality of the crop.

General Remarks.

I conceive it would be an improvement to roll moss occasionally during the progress of its cultivation. Dr. Anderson proposes to do this by a horse running upon planks; but he does not seem to advert, that it would require more men to shift these planks, than would be sufficient to draw the roller, in the way field artillery are drawn.

After a moss is laid down into pasture, it would contribute much to its fertility to lay it all over with a good dose of earth, tirrings of quarries, sand, or clay pulverized by lime, and then to roll it; this could be done in dry weather, when there is no danger of poaching, or breaking the sward.

Cattle of every kind should be kept from mosses, at first, during winter. This rule is also applicable to clay soils of every kind. Perhaps the best stock for pasturing on improved mosses would be sheep; but these have been banished from the improved moss districts, on account of the injury they do, to young planting and hedges.

I saw several mosses which were blistery, and naked of herbage, after they were thrown into pasture, on account of springs issuing from the out-crop of rocks that terminated below them. These may be cured by bored drains, and by no other method.

Hedges thrive remarkably well upon moss, where a bank is thrown up, and lime is previously wrought and mixed among the moss in the thorn-bed; but in Ayrshire, with few exceptions, they plant hedges, and then abandon them to their fate: being seldom or never weeded, the grass and other plants soon overtop the hedge, and it never becomes a fence.

I conceive that in extensive mosses, fences may be made out of the moss itself. Suppose, in place of one master drain to divide two fields, two drains were made, with an interval of 10 or 12 feet betwixt them, and all that was taken out of each drain built up upon the surface of this interval; it would form a rampart, which no animal would attempt to pass: as the cultivation of the moss went on, its surface would sink, and then it would be necessary to deepen the master drains, still throwing what was taken out of them upon the top of the rampart. As no animal could see beyond this rampart, it never would attempt to cross it.

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In Ayrshire they have roads running through the mosses, generally along the side of a master drain, and cut off from the contiguous field by a small rut on the other side. These are generally too narrow, but they serve the purpose of conveying lime, &c. in dry weather, and of taking away the crop. Were the cultivation of an extensive flow moss attempted, I see no other practicable plan but making very broad roads, drained to a great depth on each side, and laid with stone in the centre. These might intersect an extensive range of fields on each side, secured by the ramparts we have mentioned, and serve to convey lime, dung, &c. and take away the crop. At first it would be necessary to carry the corn crop to the road upon handbarrows, unless it were stacked upon the field, and taken away during frost. Potatoes, except such a portion as may be wanted for immediate use, are best preserved upon the field, in heaps, covered with moss, and can be removed during frost. After land of this kind is sufficiently limed, and wrought during a number of years, it collapses so much, and becomes so solid, that it can endure cartage almost at any time.

These things are advanced merely in the way of speculation: but the preceding part of this essay, so far as it treats of moss, is wholly composed of facts; and it surely must rejoice the heart of every good man to be informed, that mosses, which seemed to be intended as scabs and blisters, upon the fair face of nature, are actually converted into her fairest and most fertile spots.

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XV.

Observations on the Causes, and Prevention, of Curl in Potatoes. By a Farmer.

Hitherto the curl has been considered as a specific disease, arising solely from contagion, without which it is supposed, that it cannot be produced, and that this contagion necessarily propagates the disease in all crops with which it is allowed to come in contact.

This opinion, however, appears to be ill founded; and in so far as it tends to prevent the real cause of the curl from being ascertained, it continues to do harm, and should not therefore be received.

That the curl does not necessarily propagate itself is obvious, both from observation and experiment. We often perceive in fields of potatoes the most healthy plants surrounded with those that are curled, and that they not only continue in a state of health and vigour while the crop remains upon the ground, but even to be afterwards mixed with them for a great length of time, without being contaminated.

It is also known, that healthy potatoes are produced, not only from such as have been thus mixed with those that were curled, but experiment shews, as will hereafter appear, that they may be even obtained from curled potatoes themselves. Every farmer also knows that the curl often takes place where no contagion was communicated, nothing being more frequent than abundance of curled potatoes from roots chosen with the greatest care, and from fields, as well as from districts, in which the curl had never been perceived.

A farmer, whose potatoes for two or three years had been much injured with curl, judging that it happened from infected seed, procured a large supply, both for himself and some of his friends from a district on the river Tweed, where the curl at that time had never been observed; but it so happened, that while some of the crops from these potatoes were entirely free of curl, others, and particularly those planted by the farmer himself, were more hurt by it, than they had ever before been, which should not have been the case, if the common opinion upon this point was well founded, that curl proceeds from disease in the original set or root.

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We have therefore to search for other causes of curl, and all who notice it will find that whatever renders a crop poor and weakly, is most apt to produce it; and in a great measure, or perhaps entirely, that curl proceeds from this cause.

This weakly state of a crop that gives rise to curl, may take place from various causes, but the following appear to be the most frequent.

1. In this district the most frequent cause of it perhaps is, our planting potatoes on ground altogether unfit for them. Potatoes require a light, pervious, or open mould, their germs not being of a nature that can penetrate a stiff soil. This, for a great length of time after potatoes first appeared in this country, met with such marked attention, that they were never planted but in the lightest spots upon the farm, and with such care, that the plough was never employed for them: they were planted entirely with the spade, by which the soil was completely broken. Hence they had vigorous plants, and rarely any appearance of curl. But on farmers wishing to extend the culture of potatoes, and being induced thereby to plant them on every variety of soil, as they now frequently do, the crops became weak, and the curl frequent. In the culture of every other crop farmers take care to appropriate particular soils to each: for they know that they commonly fail, if this necessary piece of attention is overlooked. Those who have light sand only, do not sow beans, while on stiff clay soils the culture of turnips is never attempted. In like manner potatoes require a peculiarity of soil; and in so far as this is deviated from, the crop is commonly weak, and liable to curl.

In a field of several acres, which every fourth year was planted with potatoes, about half an acre or thereby was stiff clay, while the rest was a free dark-coloured loam, rather tending to sand, than clay. On all this part of the field the crop was uniformly strong, and free of curl, while on the half acre of clay, although manured with the same quantity of dung, planted with the same seed, and in every circumstance managed in the same manner, the plants were all weak, and a great proportion of the whole curled.

2. Imperfect culture is perhaps the most frequent cause of curl. This will be found to hold with such uniformity, that a crop of potatoes is commonly strong, abundant, and free of curl, in proportion to the previous culture given to the soil, and care taken to keep it clean after they are planted. This indeed is so remarkably the case, that excepting in very kindly soils, the additional produce from trenching and planting with the spade, is commonly more than sufficient to repay all the difference of expence,

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between this mode of culture and that of planting with the plough. On a large scale indeed, the spade cannot be employed, and plentiful crops are no doubt often obtained with the plough; but many are not sufficiently aware of the full necessity of ploughing and cleaning their grounds sufficiently before the crop is planted; for if the mould is not previously well broken it cannot be done afterwards, so that the plants are weak from their first appearance, and a great proportion of the whole, curled. The effect of complete previous tillage in the culture of potatoes is indeed so remarkable, that there is reason to believe, that the amount of our potatoe crop, in a great proportion of cases, would be more than double of what it commonly is, if the ground on which they are planted was previously put in better order. Of this many proofs might be given, but I shall only mention two: a farmer, who every year planted several acres of potatoes with the plough, allowed his cotters and servants to plant nearly two acres for their own use, but these last being commonly on spots of difficult access, could not easily be managed with the plough, and being always in bad order, they were planted with the spade, in the form of what is usually termed lazy beds: the effect of this uniformly was, that although the crops, even of those planted with the plough, were always good, being sometimes at the rate of three hundred Winchester bushels on the Scotch acre, and weighing from eight to ten tons, the others, in different instances, weighed more than the double of this, and for the most part were entirely free of curl.

The writer of these observations, soon after getting possession of a farm, being late in overtaking his potatoe crop, a considerable part of a field, which happened to be both full of root weeds and not sufficiently broken, was in that situation planted by his servants before he knew of it; but half an acre or thereby, being still worse than the rest, it was kept either with a view to give it a complete fallow, or to sow it with tares. The season, however, being dry, which favoured the cleaning of ground, this piece was three times ploughed, well harrowed after each ploughing, and the root weeds gathered and carried off. Being now in fine order, it received the same quantity of dung which was given to the rest, it was planted with potatoes taken from the same quantity, and in every other circumstance managed in the same manner, but the event was widely different. Although a week later in planting, the crop was sooner above the surface, the plants were stronger from their first appearance, and scarcely a curled stem to be met with, while in every row of the others the curl was frequent. The ground was kept clean with less than a fourth part of the expence and trouble; the produce was more than double; the ensuing crop of wheat was considerably better on this piece, and the

ground continued in every respect in better condition till the third crop, when more pains was taken with the rest of the field.

3. I have reason from experiment to think, that small roots, or too small a portion of strong roots, being given to each set, has an influence in producing a weak crop, and curled plants. It is perhaps equally necessary in the culture of potatoes, as in that of wheat or any other crop, to make a choice of healthy full grown seed; but this is not always done: small potatoes are often indeed purposely kept for planting, instead of those that are full grown, and therefore more capable, we may suppose, of producing a vigorous progeny. In like manner there is cause to suspect, that our frequent attempts of late years, to discover new varieties of potatoes, by raising them from seed instead of the root, has had some influence in rendering the curl more frequent, plants raised from the seed being commonly for the first two or three years very weak and feeble.

Sixty-four sets were planted; sixteen of which were full grown potatoes; sixteen from small roots, in which no curl appeared when in the field; sixteen from roots raised fom the seeds two years before; and sixteen from roots of plants strongly curled. They were all planted in the same manner, in a light soil, and in furrows parallel to each other, with a moderate quantity of dung to each, and covered to the depth of three inches. Of those taken from large potatoes, none were curled, and the plants were all strong and healthy. Some good plants appeared in each of the other rows, but nearly a half of the whole were curled. The proportion of curled plants was greatest in those lately raised from the seed: in the other two rows, they were nearly the same. The row planted with curled potatoes had seven curled plants, and the other only six; but in this last row, the other three were so weak from the first, that although not obviously curled, they soon began to shrivel, and in the course of two or three weeks disappeared entirely.

4. It has been mentioned by a noted planter of potatoes, that sets taken from roots that have sprouted early, and from which the germs have been rubbed, as is commonly done, with a view to the preservation of the sets, never fail to produce curl. The plants which succeed to the second production of germs are always, he observes, very weak, and with such certainty produce curl, that he is induced to consider this as the only cause of it; but this attentive observer will find, that whatever tends to render a crop, or even particular plants in a crop, weak and delicate, will in like manner seldom fail to produce curl.

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5. Too much as well as too little dung appears to have influence in producing curl; the first may probably act by corrupting the germ of the young plant, the latter, by not being sufficient to produce vigorous plants.

This effect, resulting from an unequal application of dung, may perhaps be considered as the most frequent cause of that partial appearance of the curl, that we often meet with in fields, managed all apparently in the same manner: for dung is often spread in such a careless slovenly manner, that while some of the plants have none, others have it in too great a proportion, being sometimes covered with it to the depth of several inches.

6. Too deep as well too shallow planting are both apt to produce the curl, but the first of these errors is perhaps the most frequent. The sets should never be placed deeper at first than three inches, however useful it may afterwards prove to lay the earth up to the stems; but instead of this, by the usual method of planting in drills, or ribs as they are termed, and throwing two deep furrows over the plants, they are frequently covered to the depth of nine or ten inches, by which, from a total exclusion of air, and perhaps from other causes, the crop is always late in piercing the surface, and many of the plants are weak and curled. These ridges are indeed commonly harrowed down at last, but often not, till it is too late.

Where again the plants are placed too near the surface, if the ground itself is dry, they rise in weak feeble stems, and many are curled from want of moisture alone.

With a view to ascertain the best depth for sets of potatoes, twelve were planted at eighteen inches deep, the same number at the depth of sixteen inches, fourteen, twelve, ten, eight, seven, six, five, four, three, and two inches; and twelve were so lightly covered, that they were not perhaps at the depth of one inch. The sets were all from large roots of the same crop, and all as nearly as possible cut of the same size: they were all planted at the same time, in the first week of April, in a light dry soil, and they all got the same quantity of dung, and in every other circumstance were managed in the same manner.

The plants at the depth of one, and two inches, appeared first, but they were weak, and some of them curled. Those at three, four, and five inches were all strong, healthy, and entirely free of curl. At six and seven inches they were also healthy and free of curl; but they were three weeks later in getting above the ground, than those that were thinly covered, and the plants neither so strong nor the roots so large. Those planted at the depth of eight inches were still later in piercing the surface; they were all weak, and

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nine out of the twelve were curled. Only four ever appeared of those planted ten inches deep, and they were so weak that they very soon withered and died. Of those placed at the depth of twelve, fourteen, sixteen, and eighteen inches, none ever appeared; and on digging them up at the end of two months, those at sixteen and eighteen inches deep were found just in the state in which they were planted, without any appearance of vegetation on any part of them; while some of those at the depth of twelve and fourteen inches had put forth some feeble germs, none of them exceeding the length of an inch.

Those planted at the depth of three and four inches were evidently the strongest plants during the whole season, and their roots largest. Those at five inches deep were nearly equally good, but they were ten days later in appearing above the surface, and the stems never became so strong, nor the roots so large, as the others, not so deeply covered. I am therefore convinced, from the result of this as well as other experiments on the same object, that about three inches is the best depth at which potatoes can be planted; that the crop will be more or less early, abundant, and, in general, more or less injured with curl, according as the roots are placed at a greater or less depth than this. The result even of the same experiment upon this point may indeed be different in different soils and seasons, but I have much reason to think, that in general, it will be nearly the same.

7. Whatever injures the new planted sets, or the germs afterwards, may produce curl; such as the sets being trampled upon and broken by the horses' feet, in the time of planting; particular sets being partially covered with stones or impenetrable clods of earth; severe and deep harrowing, when the young shoots are advancing; and grubs, snails, and other insects, destroying the germs at first, or the stems afterwards.

8. Some years ago, when on a journey, I observed a field with a greater proportion of curled potatoes than I had ever before seen, by which I was induced to inquire into the culture of the crop. The ground I found was stiff, and not having been sufficiently broken before the crop was planted, the farmer had passed a roller over it about a fortnight after planting; the effect of which was, that many of the plants did not appear at all, and a very uncommon proportion of those that came forward, were curled. This might in part be owing to the state and nature of the soil, but in a great measure it seemed to depend upon the solidity given to it by the roller, for in the contiguous field, where the soil was exactly similar, the plants were more vigorous, and the curl not so frequent.

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9. The state of the weather, while the crop is young, has an obvious effect in rendering the curl more or less frequent. It does not appear that rain, in whatever quantity it may fall, has any effect, if it be not allowed to lodge; and if the soil is such as potatoes ought to be planted in, that is, a light pervious loam, with little or no tendency to clay. But we frequently find, that a long continuance of dry weather, when the shoots first come forth, particularly when accompanied with severe cold winds, is very apt to produce curl. In this early state of the crop too, frost seldom fails to produce it, particularly hoar-frost.

This should lead farmers to fix on that season for planting, in which they find from experience that their district of country is least liable to be injured by these causes, and chiefly by cold winds, frost, and a long continuance of dry weather. So far as the writer of this has observed, the first, second, or third weeks of April answer best for the South of Scotland, and North of England. Potatoes planted at this period do not appear till the middle or end of May; after which, if it be not in low fields, contiguous to rivers or marshy grounds, in which hoar frosts are frequent, they seldom suffer from frost, at the same time that dry weather does not hurt them so much as it commonly does, when they do not appear till the middle of June, when the heat and evaporation being more considerable, any scarcity of rain proves more particularly hurtful to all such plants as require a full supply of moisture, and which certainly is the case with potatoes while the plants are young, and do not cover the ground. For although good potatoes cannot be raised on soils naturally wet, every farmer may observe, that nothing tends with more certainty to prevent curl, and produce vigorous perfect roots, than frequent showers in the early state of the crop.

As a proof of the influence of winds on crops of potatoes, and in the production of curl, may be mentioned, what the writer of this has several times observed, that in the district of country in which he resides, where easterly winds commonly prevail during the months of April, May, and June, all such fields as are sheltered from this wind by high walls and hedges, do not so readily produce curled potatoes as others commonly do. In two instances in his own fields it has happened, that the plants on those ridges immediately west of a stone wall have been strong, and entirely free of curl, while the rest of the crop was poor, with several curled plants in every ridge, although the seed and culture was the same over the whole.

The general result of all these observations is, that the curl is not a disease, but only an accidental debility of those plants in which it occurs. We are not therefore to seek

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for a cure or preventative, in a change of seed alone, as many have all along done, but in complete attention to all, that experience shews to be necessary for an accurate culture of the crop: from which alone, there is much reason to think, that this very useful article of life may be cultivated with the same success, as before this, its dreadful enemy, the curl, made such havock in our crops, as of late years it certainly has done.

The writer of this has reason to think, that observations similar to those which he now offers to the public, would long ago have been made by others, for they are so obviously well founded, that they could scarcely escape notice; but the opinion which he has endeavoured to combat, of the curl depending on infection, so entirely occupied the attention of farmers, that almost every other was overlooked. This, there is reason to hope, will not long be the case; and that it will appear to be equally ill founded with another opinion, which also continued for a time to prevail, that the curl arose from a too frequent culture of potatoes on the same ground. In regard to which it is only necessary to observe, that in those districts where the curl was first perceived in an alarming extent, it has occasionally disappeared altogether for a season or two, and in some instances has not appeared again, which could not have happened if a more frequent repetition of the crop was really the cause of it; upon which also it may be remarked, that within these last twelve or fifteen years, the curl has been equally frequent on new grounds never under potatoes before, as in those which have been most frequently planted; owing, as there is reason to think, to the same attention not having been given, for some years past, to the culture of this valuable root which it certainly merits, which, till of late years, it very universally received, and by which better potatoes, as well as a greater produce, was commonly obtained, than we now in general meet with.

We are not to suppose that the curl, even by the best management, is ever to be entirely prevented. Particular causes, such as those that I have enumerated, will occasionally make it appear in particular plants: and in seasons singularly bad, even a considerable part of a crop may be hurt by it; but particular causes will have no general effect; and with due attention to the season of planting, there is reason to think, that farmers have it in a great measure in their power, to obviate even the influence of weather.

But although there is no reason to imagine, even with the best management, that the curl can be completely banished from our fields, yet with due care to these leading points in the culture of potatoes, the use of large sets taken from full grown roots;

the soil in which they are planted being entirely fit for them; having no tendency to clay, but being on the contrary sufficiently light and dry; completely reduced to a find mould, and cleared of root weeds before the crop is planted; that season, as I have already observed, being chosen for planting, which the experience of every district shews to be the best; a due quantity of manure being equally spread; the sets being placed at a proper depth, and at due distances from each other; this, together with the entire destruction of weeds, as frequently as they appear, and earthing the plants properly up during the first weeks after they rise above the surface, with a view to encourage a full production of roots, will in almost every instance prevent any important loss from curl, and would very universally ensure abundant crops of dry wholesome roots, instead of those scanty productions of bad, and there is reason to fear, unwholesome potatoes, which to the disgrace of many of our farmers, are in various districts frequently met with.

Mid Lothian.

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XVI.

On Irrigation, or Watering Land. By Mr. Joseph Fenna, *of Baddly, near Namptwich.*

Since the practice of watering or floating meadow or pasture lands may still be said to be in its infancy,* a description of the following method, which probably has something new in it, may not be deemed impertinent.

The farm house and yard, represented by the annexed plan, is situated upon a stratum of clay and marl to a considerable depth, and therefore the water in rainy seasons is not much decreased by absorption. The sap from the dunghills, and moisture from the cowhouses, &c. is collected in the reservoirs *a, b, c, d.* The moisture from the wash-house, stables, pig-sties, necessary, &c. which only runs during rain, and a few hours after is distributed upon the field, No. 1, by the gutter which is here called the first level. This farm house, &c. is unfortunately situated upon the highest ground, with a declivity from it, in all directions, which prevents any additional water being brought to it by collecting gutters; and therefore the whole quantity here used, is what falls form the clouds upon the buildings, yard, &c. (being about two acres of ground) and yet this, inconsiderable as it is, promises to be sufficient for the maintenance and improvement of eight acres of land for mowing or pasture. The wash from the yard, previous to its being used for floating, proceeded in the direction of the dotted arrows. The black arrows shew the new cuts, and their points the course of the water in them. The figures annexed to the gutters belonging to each level, shew their declivity in inches below the first or summit level, as the ground declines. The first, or summit level being marked with *o o o.* The field, No. 1, has been often in tillage, and consequently lies in ridges or lands, as left by the plough, which occasions the zig-zag, or angular form of the trenches, or gutters, cut at each level, in order that they may be of no greater depth or dimensions in the ridges than in the adjacent furrow, or what

* In Cheshire this writer means; for in various other counties of this kingdom irrigation is as near perfection as the tenderness always manifested to private property by the British legislature will permit: could canals for this purpose be carried as for navigation, more land would be watered, but perhaps not better than some is at present.

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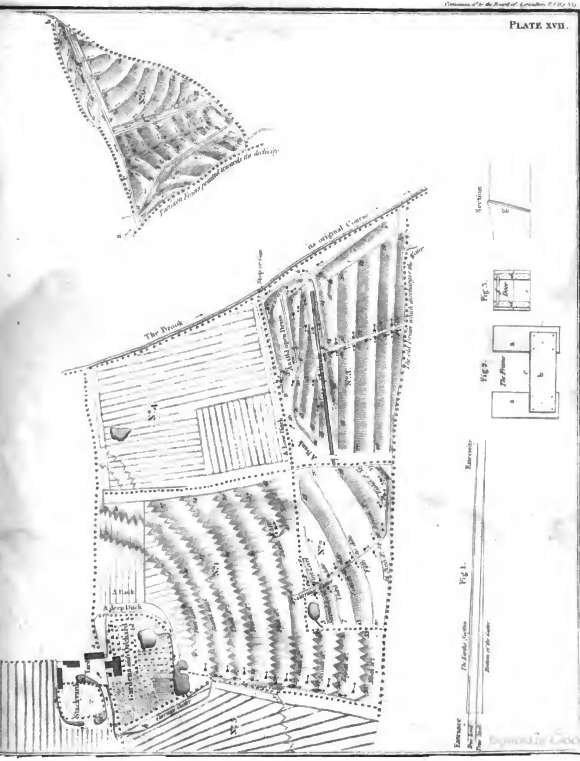
PLATE XVII.



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is here (in Cheshire) called rean: and that each level may, when charged with water, discharge it equally, over the lowest edge from end to end at the same time.

The gutters cut in this field are, at the end where it receives the water from the carriage gutter, 8 inches wide at the top, and 8 inches deep, sharp at the bottom, or of no breadth, commonly called a prickt gutter, gradually tapering to the extremity, where it is no more than 4 inches wide, and 4 inches deep. They are set out by a spirit level, and though here called levels, have about half an inch draft or fall, allowed them for the run of the water in every 10 roods. They are cut across the declivity of the field, at the distance of 10 or 15 yards from each other. The sod taken from a gutter of this sort is prismatic, or wedgelike; and one of the largest, at the end adjoining to the carriage gutter, is retained and used for a stop, and placed either in the collateral level, or the carriage gutter, as occasion may require; the others have here been chopped to pieces, and spread in the furrows or reans, in order, in time, to make the field more upon a level. Where not wanted to level hollow or low places, they should be carried into heaps, and mixed with dung for a compost. There is no part of any gutter raised by the stuff taken out, and therefore the mower meets no more obstructions, than he did previous to their being cut.

Method of floating the Field, No. 1. *(Six Acres.)*

When it rains, the reservoirs are pounded up as high as they can be, without injury to the yard (in this 8 or 10 inches each), whilst the rains from the north side of the buildings *(a)* including the wash from the wash-house, pigsties, necessary, &c. are collected in one gutter, or deep ditch, as shewn by the dotted arrows, and turned into the first level by the stop at *(b)*, which becomes filled from end to end, and flows down the declivity of the field, as shewn by the faint shaded lines; but the tendency the water has to quit the ridge makes it necessary to cut a small channel in each ridge 2 inches wide and 2 deep, as shewn at *c, c, c*. After passing over the slope, or part immediately below the first level, it is again collected by the second level, and dispersed over its flat, and in the same manner over the third, fourth, fifth, and sixth. But when the water is wanted for the meadow, No. 2, the sixth level becomes a collecting gutter; and by removing the stop at *(d)*, its contents are poured through the gateway into that meadow (which will be hereafter described). The seventh, eighth, ninth, and tenth levels receive their shares from the levels above them, which they in like manner distribute over their respective slopes. If water is wanted to the tenth level in particular,

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all the stops in the carriage gutter are opened till you come to (*e*), which is shut; the stop is shut at (*d*), and (*f*) is open, which permits the water to pass freely into the tenth level. When it is wanted in the seventh level, the stop (*e*) is removed, and (*g*) retained in its place; and in like manner for the eighth and ninth levels. If the reservoirs in the yards are filled before the abatement of the rains, the overplus breaks over the mounds, runs down the carriage gutter (*b*) across the bridge and through the gateway (*i*), where it takes the second level, or is conveyed into any other by the carriage gutter (*k*), or to (*e*), where the sixth level conveys to (*d*), which being opened, empties it into the meadow, No. 2. One or two days after the abatement of the rain, when the surface of the field appears dry, the reservoirs of black thick water are let out and conveyed over the surface of No. 1, and 2, by the means above described. The reason it was not let off sooner was, the quantity of rain falling might carry it over; the reason it is not used later, or in dry weather, is, the ground is then open and porous, and the reservoirs do not hold a sufficient quantity to reach far upon the field.

The Meadow, No. 2,

Is represented in the plan part floated and part dry, and may be changed daily, or each division floated in rotation one after another (at the option of the owner, provided there was a continuance of water); the former is upon the same principle with this, though not before described. It will here be necessary to explain more particularly the nature of a level, or floating gutter, and to shew that the water will pass forward, and overflow the division immediately under, or the slope declining from it; acting upon it like the trenches described in Mr. Boswell's Treatise on Watering Meadows, though destitute of bends; and yet the same gutter shall act as a tail drain to the next floating one above it, by the waters running in a contrary direction to what it did, when full for floating.

Fig. 1. in the plan, is a longitudinal section of a floating gutter or level, as it is before called, of the same dimensions as before described, viz. 8 inches deep at the end next the carriage gutter, and 4 inches deep at the other extremity. The upper line shews the earth's surface with half an inch dip allowed at the distance of every 10 roods, as you proceed to the extremity. The lowest line shews the bottom of the gutter. The two middle parallel lines shew the true level. When the stop is placed in the carriage gutter, the water is forced into the level, or floating gutter, which becomes filled to the surface; it is then evident that the action of the water will be forward towards the

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extremity, as there is a declivity of half an inch in every 10 roods. But when the stop is removed, and the water has liberty to descend down the carriage gutter, it is as evident that the water in the floating gutter will take a retrograde motion, acting entirely on the bottom of the gutter, where there is a greater degree of dip from the extremity to the entrance, as is seen by comparing the bottom line with the true level, and, consequently, it will run with a greater velocity out, than it was forced in. The black arrows shews the course of the water when full, the red one its retrograde motion when emptying back.

In the plan of meadow, No. 2. the divisions or slopes under the second, fourth, seventh, and ninth levels are represented as floated, all the others dry. It has been before observed, that all the water used upon the first, second, third, fourth, and fifth levels, in the field No. 1. may be collected by the sixth level, and emptied by removing the stop at (*d*), for the purpose of watering this; or it may be brought here immediately from the yard, by means of the carriage gutter (*b, i, k* to *e*,) and from thence by part of the sixth level to (*d*), where it pours down the main carriage gutter, in No. 2, whose stops send it off into any, or all, of the collateral levels; or, as is intended to be described, it passes by the first level, whose stop is removed from the carriage and placed in its entrance, to the second level three inches lower, where meeting with a stop, it is thrown off sideways into the second level, marked 3, 3, and then passing over the division or slope next under it, is received and sent back by the level marked 7, 7, to the main carriage, which conveys it to the fourth level, 13 inches lower than the summit, or first, where meeting with a stop, it is sent off both ways to the extremities, and after passing over its division or slope next under it, is again collected and sent back to the main carriage by the fifth level, marked 20, 20, 20, from whence it proceeds, unobstructed, to the seventh, whose stop again sends it off, and after being collected by the eighth, is again dispersed by the ninth, whose stop discharges it into the ditch. The stops are shewn by a black stroke across the gutter in the plan. It is plain, that, by changing the stops, that, that part now floated will run dry, and the other part, now dry, may be floated in its turn; or, each one separate slope may be floated itself, independent of the other, which if daily changed would come round again to the same every ninth day.

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The Meadow, No. 3. 4 *a.* 2 *r.* 0 *p.*

Is a thing soil (probably brought there by the wash from the adjacent uplands) upon a turf: it has been watered about three years, by diverting the stream of a small adjoining brook, whose head is about one mile above, and is supplied by rain water discharged from about 150 acres of chiefly clay land, aided by a few springs: in dry times the whole would pass through a pipe of three inches diameter: in rainy seasons will fill a channel two feet square. In these few years watering, this meadow has considerably improved both in quantity and quality of its hay.

The method used in watering this meadow is as follows: a stop is placed across the bank at *(a)*, which turns the stream by a cut through the hedge into the carriage gutter *(b)*, which meeting with another stop at *(b)*, makes it fill the summit level, being a gutter 18 inches wide and 2 feet deep, marked *(o, o, o)*. The pressure of the increasing stream then forces the water over the division or slope below it, as is shewn by the faint shades upon the plan. (N. B. These shades are not drawn quite across the slope or division where the water passes, to prevent confusion.) The water after passing the slope is received by the old open drain 2 feet wide and 2 feet deep, from whence it passes under ground at *(c)* by a covered drain into the other old drain, and is discharged from the meadow. A small quantity is let off out of the summit level at *(d)*, for the supply of a small level three inches lower. There is a trunk inserted at the mouth of the covered drain at *(c)* with a stop, which when shut, forces the water into another level 10 inches lower marked 10, 10, 10. The stop at *(e)* (in gutter 8 inches wide and 8 inches deep) being removed, the water presses down those small tapering gutters, such as have been before described, and waters the whole of the division, one acre lying between the two old open drains, as may perhaps be sufficiently shewn by the direction of the arrows and the shades. When wanted to be laid dry, a stop reremoved at *(f)*, discharges the whole. The reason the summit level was not carried farther than *(d)*, was owing to the low deep ditch, acting as a drain to a bog, which is emptied by a covered drain, shewn by the double dotted lines *(w)*.

The stop being removed at *(b)*, the water presses down the carriage, and, meeting with obstructions at *(g)* and *(h)*, fills the level marked 7, 7, 7, upon the rise of the hedge back, and overflows its slope; the gutter marked *(i)*, is only to intercept and prevent the waters tailing too far upon, and starving the other divisions. Remove the stop at *(b)*, and the level marked 16, 16, is floated. The level marked 14, 14,

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would float this last, but it was thought to carry too far, and this short one was introduced. Remove the stop at *(g)*, and the level 14, 14, is filled, and flows over each side; this is an artificial level, that is made so with the soil from the others being laid to its sides, in order to water the division sloping to the old drain. Remove the stop at *(h)*, and the level 16, 16, is filled; which like the former is made level; all the others are the natural surface, which permits the mower to pass, uninterrupted, over the gutters, in any direction, with the usual stroke of his scythe. Remove the stop at *(l)* and the level *(m)*, marked 18, 18, 18, is filled, and floats its subjacent slope, or division. When *(m)* is removed, the water is thrown off each way at *(n)*, and in like manner at *(o)* and *(p)*; which last stop, when removed, will empty the whole in the lowest drain, when it is wanted to lay the meadow dry: any one of these divisions or slopes may be floated by itself, independent of the other, by putting down its stop in the carriage, and letting all the other be open, or every other division, by placing down every other stop, or the whole at once, at the pleasure of the owner.

These, like those in No. 2, answer as trenches and tail drains to each other, as occasion shall require, being 9 inches wide and 12 inches deep, at their conjunction with the carriage gutter, and 7 inches deep at their extremities. It may be observed, that as the carriage gutter at *(b)* is 18 inches wide and 2 feet deep, and that it tapers or lessons as it proceeds past *(g, k, l, m, n, o,* and *p)*, at which last place it is only 9 inches wide and 12 inches deep, that when a body of water at *(a)*, filling a carriage of 2 feet square, enters the meadows whose carriages are narrower, a part of it must be thrown off over the banks, and, consequently, float the whole as it passes along without any of the stops being shut, but that at *(p)*. It may not be amiss to describe the stops used in this meadow, which for simplicity and trifling expence, may not be unworthy of notice. Fig. 2. represents the frame for a trench or gutter, 12 inches wide and 12 inches deep; *a, a,* two bases, or rough boards of oak, 2 feet long and 8 or 9 inches wide; *(b)* another board 2 feet long and the same breadth, the upper edge *(c)*, of which is shot true by a joiner's plane; this is nailed to the two former, 14 inches from the top, as represented. This frame is let into the ground at the bottom and both sides of the gutter, so as not to stand perpendicular, but to lean a little at the top, as if pushed by the force of the water; see the section *(g)*; the two ends being left 2 inches above the surface, are patched round with sods and made level, so as not to obstruct the mower's scythe; the reason of its being left a little higher than the other parts of the level is, that the impetus of the water, whose course it immediately

obstructs and turns, may not beat over it. The dotted margin, when set down, is all that appears unburied. The figure represents the front side, or that facing the stream.

Fig. 3. The door consists of 2 inch boards, well jointed and kept together by two cross pieces *(d, d)*, nailed thereto, the outer edges of which fit to the cheeks of the frame *(a, a,)* and the bottom edge *(e)*, to the edge of the frame. Another small slip *(f)* nailed to the cross pieces, serves for a handle to remove it by. This figure represents the back side of the door; when placed down, the force and weight of the water pressing against it, keeps it sufficiently close. No. 4, might be floated in the same manner as No. 1, was there a sufficiency of water; in that case, the second level in No. 1. must be deepened at the extremity, and when a stop was removed at *(x)*, it would become a carriage gutter for it.

The overflowing of the pits, in the garden passing down the ditch under the other carriage gutter at *(i)*, is arrested at *(y)*, and turned over the bottom of the field, No. 5, which improvement, though small, is too evident to be neglected.

The Meadow, No. 6. 4 *a.* o *r.* o *p.*

Is an ebb cold soil upon clay. The water here used flows from the adjoining uplands, in rainy seasons, in two small streams (a) and (b). The greatest quantity after their junction might pass through a pipe 2 feet in diameter. The double dotted lines shew their original course and junction, but of late years have been turned down the ditches belonging to the partition fences. The old drains, shewn by the double dotted lines, are now filled up, and levelled by the stuff taken from the new trenches, which are marked in the plan by double black lines; (c) and (d) are two carriage gutters which form a junction of the two streams, and convey a quantity of water to the middle part of this meadow; their dimensions at the mouth or entrance is about 16 inches wide at top, 9 at bottom, and 16 deep, tapering as they approach each other, where they form the first level for the middle part, marked with the figures 14, 14, 14, 14; (e) and (f) are two drains of the former dimensions, which carry off the refuse water. All the other trenches or gutters, are small triangular or pricked gutters, such as were particularly described in the Meadow, No. 2. The carriage gutters, or those which convey the water to the different levels, are shaded darker in the plan. The levels, or floating gutters, are left open or white. A little attention to the direction of the black arrows will shew the action of the water through the different gutters, and the faint shaded lines its action in passing through the grass. The plan represents the meadow

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when there is a sufficiency of water to float the whole at once. The black lines across the carriage gutters, shew the different stops, which are nothing more than a sod, that throw off a quantity of water for the use of its respective level: should any one or more of them be removed, the slope next under it will become dry, and, consequently, any separate part of this meadow may be floated, independent of the others. The figures are here placed to the levels, to shew the fall in inches below the summit or first, marked with *(o, o)*.

Directions for Watering Land upon the first mentioned System.

By the assistance of a spirit level, bring the water to be used upon the highest part possible of the land to be floated, by a carriage gutter to be cut for that purpose; and then set out a level to the right, or left hand, which ever shall present, continuing it along the brows, in any form that the level may dictate, to the boundary of the meadow, allowing half an inch dip to every 10 roods: let a gutter be cut sufficient in dimensions for the quantity of water, in the same manner as before directed; that is, deepest at the beginning or entrance. This may be called the first, or summit level; then continue the carriage gutter down the declivity of the land 10 or 15 yards farther, and set out another level either to the right hand or left, or both ways, as circumstances shall direct, and in the same manner continue your carriage, setting off your side levels at every 10 or 15 yards till the whole is completed.

The nearer the levels are cut to each other, the greater will be the improvement. In sound land the gutters need not be so deep or great. In wet or boggy land, cut them as deep as the quantity of water can fill to float them, but not deeper than the fall (at the bottom of the meadow) will empty; for when these cuts are not used for floating, they act in the best manner possible for draining.

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No. XVII.

Experiments with Salt. By Mr. Joseph Fenna.

On Fallow.—July 1st, 1797. Experiments on a fallow for wheat being once ploughed, and that before Christmas last, full of grass and weeds, owing to the continual wet weather.

		A.	R.	P.		lbs.		Bu.	lbs.
3	butts	0	2	4	sown with	$85\frac{1}{2}$	of salt, that is,	2	50 per acre.
2	ditto adjoining	0	1	26	unsown				
3	next ditto	0	2	35	sown with	89	of ditto	2	11
2	ditto	0	1	35	unsown				
3	ditto	0	2	5	sown with	130	of ditto	4	20
2	ditto	0	1	13	unsown				
3	ditto	0	1	34	sown with	193	of ditto	7	25
3	ditto	0	1	7	unsown				
3	ditto	0	1	34	sown with	175	of ditto	6	42
3	ditto	0	1	17	unsown				
3	ditto	0	1	13	sown with	195	of ditto	10	25

Observations.

July 12th, 1797. Some few of the weeds have perished, but no other evident alteration compared with those unsown, and none at all upon those sown with small quantities. Ploughed under between the 7th and 14th July, the weather being rather drying, but still showery.

July 12th. Salt sown on the same fallow being twice ploughed, the weather drying.

		A.	R.	P.		lbs.		Bu.	lbs.
1	butt	0	0	22	sown with	$76\frac{1}{2}$	of salt, that is,	9	49 per acre.
1	ditto	0	0	18	sown with	$78\frac{1}{4}$	of ditto	12	21
1	ditto	0	0	33	sown with	109	of ditto	9	34

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Observations.

Some few snails perished by the application the day following. No other preceptible alteration has yet taken place. August 28th. Has been harrowed and ploughed a third time.

Note. A man sowing from a seed bopper, common stride and full hand, twice over the same ground, will sow from 10 to 12 bushels per acre.

Oct. 1st, 1797. Sowed another butt in the same fallow with salt, immediately before its being sown with wheat, and ploughed in therewith, being after the rate of 10 bushels per acre.

No visible advantage has been seen in any of the above through the winter, or at spring, nor any perceptible advantage as the crop advanced to maturity; neither could the reapers, nor any other viewers, distinguish the least appearance in favour of salt, compared with the butts unsalted.

On Pasture.—June 30th. Sowed 0 a. 0 r. 17 p. of pasture with 4 lbs. 4 oz. of salt (being rye grasss and clover of the second year's growth, soil pretty good upon marl.)

Sowed 0 a. 0 r. 13 p. with salt (3 lbs. 12 oz.) being pasture of several year's growth, full of wild or natural clover: soil deeper and warmer than the former.

July 1st. Sowed 0 a. 0 r. 35 p. with 17½lbs. of salt, being pasture of the third years growth; soil open, upon sand productive of fern.

December 1st, 1797. Sowed part of a butt with salt, after the rate of 15 bushels per acre.

Dec. 1st. Sowed 8lbs. of salt on part of a rough meadow, baving nearly its whole summer's growth of sour grass, which the cattle would not eat, and has been usually burnt off at spring.

Observations.

July 12th. No evident alteration compared with the adjoining land. August 28th, continues unaltered.

In spring 1798, not forwarder, nor anywise preferable to the adjoining butts of ground which were not salted.

Some thistles and some little of the fern damaged, but not destroyed. The rough or sour grass being in a withered, or dead state, though sown with fine salt

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when dewy, was not affected thereby, neither did the cattle prefer it to the other not salted.

On Mowing.—July 27th. Sowed 39½ lbs. of salt upon 0 a. 0 r. 14 p. a cold peaty meadow (herbage indifferent intermixed with rushes), immediately after the hay being carried off, the weather dry. N. B. 8 bushels per acre,

Observations.

July 29th. The weather broke and much rain has since followed, but no visible alteration has yet taken place. August 27th. This is not a sufficient quantity to destroy the herbage, nor has any advantage yet appeared. Neither has the spring nor the crop of haygrass shewn any thing preferable to the unsalted parts adjoining.

On Hay.—August 13th. Scattered 3 lbs. of salt in a ton of new hay at the time of housing, being a little weathered. This hay appeared less mouldy, and on that account was better than the same unsalted, but would not compare with the like hay which had not been weathered and not salted.

On Weeds and Brambles.—June 30th, 1797. Applied 4 oz. of salt to 4 weed wiss (in Gerrard's History of Plants called *genistella tinctoris*, dyer's weed, or bastard broom) tufts, or roots, occupying a space 12 inches in diameter, in equal quantities. The ground being wet with almost continual rains for a month past.

Observations.

July 1st. Began to droop. July 12th, dead. August 28th, three of them are rotted away, and their place growing over with grass; the other has its woody substanee yet standing, though dead. These sprang up from the old roots this spring 1798, and have continued in the same flourishing state as they were before the application of salt. July 1798.

1797, July 1st. Applied 7lbs. of salt to a number of the hard kind of rush tufts, or bogs in the pasture.

Observations.

The cows found it the next day, and collected as much as they could together, with every blade of grass growing amongst the rushes. Some few of the rushes were

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bit off in consequence of their search; the remainder did not die, nor suffer any apparent damage from the application, August 28th. It has been found, by subsequent trials, that the cows take this, in the act of licking the grains of salt with their tongues, and that where the grains have been dissolved, the herbage is not preferable, on account of its having been salted.

1797, July 12th. 10 lbs. used upon a poor furze, or gorsey bank, chiefly clay soil, being then almost totally overgrown about 12 or 16 inches high; in quantity about 80 square yards; the weather dry.

Observations.

The cows found this, and stole all that they could get at, together with any decent herbage, with which it was intermixed. Some little of the gorse has perished, but is far from being destroyed.

Aug. 28th. The whole recovered at the return of spring (1798), and so continues.

July 12th, 1797. Used 8 lbs. of salt upon a number of weed wiss, or bastard broom, tufts, or roots (the four salted the 30th ult. being dead) the weather dry.

Observations.

July 27th. They are in part destroyed. The cows found this and collected as much as they possibly could, without eating the weed, which is very bitter.

N. B. These retained their verdure much longer than those salted in wet weather. —August 28th, not yet destroyed, but much hurt. These like the former recovered at spring 1798, and so continue (July 1798.)

1797, July 12th. Used 10lbs. of salt upon more rush tufts or roots in the pasture, a greater quantity to each.

Observations.

The cows found it in a short time, and selected every grass from amongst the rushes, together with as much of the salt as they could. Some of the rushes suffered in the pursuit, being bitten off and thinned.—Aug. 28th. The rush roots are too deep to be destroyed. Grass, and other herbage near, has suffered. These, in 1798, are not to be distinguished from the others not salted.

1797, Aug. 25th. Usued 6 lbs. upon 15 square yards of ground almost totally over-

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grown with hen-gorse (in Gerrard's History of Plants called *ononis, sive resta bovis,* cammock or rest harrow), a pernicious woody shrub infesting clay soils, being then in full flower, and begining to set its seed pods: the weather showery.—August 28th, the leaves and flowers are dying. The branches died soon after, but the roots sent out fresh ones at the return of spring, which still continue. This being upwards of 30 bushels to the acre, destroyed the intermixed grass, which became brown and lifeless till the approach of winter, when it began to recover, and the whole was covered by the spring; but no better herbage than the adjoining; nor has it any time since, been preferable, July 1798. This quantity was not sufficient to leave the ground quite bare. Though the herbage was killed, it never totally disappeared. If a lesser quantity would have done so, it might have been serviceable for destroying the sward, previous to the making of a lay fallow. Salt has been used from 15 to 20 bushels per acre, upon small patches of nettles in deep soiled pasture, which were fretted awhile, but afterwards recovered without any visible alteration.

It has likewise been tried (1798) in various proportions, and at different times, upon a turnip fallow without any good effect. It was sown upon a weedy part of the turnips to the amount of 10 bushels per acre; after they were up in three or four rough leaves, these were fretted; but the greatest part of both weeds and turnips recovered, with little variation from the other (rather worse if either.) How salt would act upon worms, or what is called the fly, is not known, as the crops were not plagued with them this last year; probably it would have a good effect; for salt water was tried upon worms on a gooseberry bush, without fretting the tree much, the worms soon after died, but, as this was only one instance, perhaps a change of weather, or some other cause, might occasion their death. This experiment is intended to be repeated both on turnips and on gooseberries.

With Cut Straw salt has been tried, mixed and immediately given, put together and left to ferment, and sprinkled with salt and water; in every case it is refused by the cattle.

In Manure, salt mixed with dung, in various proportions and in different sorts, is not discoverable from the same sort, set on without salt.

On the 3d of January 1798, 67 lbs. of salt were mixed in 2 square yards of rough peaty parings, cut from the sides and bottom of an open peaty drain, and made in a heap of that size. The remainder of the same parings were made in another heap, and mixed up with a quantity of horse dung of proportionate value, allowing the salt

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to be worth *6d.* and the dung to be worth *2s.* per square yard. Both sorts were examined by Sir Robert S. Cotton, the beginning of August last, at which time the admixture wtth salt remained in a dead tough state, without any rotten or saponaceous particle in it; the blades of grass in the middle of the heap, though dead, had not lost their colour. No weeds or any vegetahle had grown upon this heap; but the other mixed with dung was covered with weeds, and on opening was found much reduced and pulverized; and after one good turning and mixing, was set upon the ground in good condition, in November last; the other has since been twice turned, and remains in the heap unrotted at this day, Mareh 1799. From hence it may be concluded, that salt acts not as a septic on vegetable substances, but, on the contrary, preserves them in a dead state, and acts as a preventative to putrefaction; this is perhaps more fully proved by the common method of preserving kidney, or French beans, when ripe enough for the table, which are kept the year round for eulinary purposes in pots between layers of dry salt.

Sheep. In all the different trials of sheep, both with salt scattered in different parts of their pasture, and salt and water sprinkled upon other parts, their attention could not be attraeted more than smelling to it, and quitting the place. Perhaps the notice that cows pay it, is ehiefly owing to the eustom of strewing salt upon the calves as soon as calved, which is commonly licked by the cow, more perhaps from a mother's fondness than the salt. Some cows refuse to lick them, but most will do so whether salted or not. Whetber this eustom is practised for any good purpose cannot be ascertained.

From the foregoing experiments it may be concluded, tbat salt may be of service to agriculture, in the preparation of fallows, in rainy seasons unfavourable to the plough; but in this case great quantities must be used to have the desired effect; perhaps less than 50 bushels to each acre, would be insufficient. This quantity would not destroy vegetation for more than two months, as appears from the first experiment with weedwiss, where something more than that quantity was used: this quantity might destroy the weeds, but would not reduce it, if in a tough or soddy state, as appears from the last experiment in manures, where the quantity used is equal to 240 bushels per acre, allowing it to penetrate the surface of the fallow, in an equal degree, only three inches deep.

Perhaps it would be more beneficial, used in small quantities with hay, at the time of housing or stacking, which, if weathered or damp, might prevent it in some degree

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from moulding, and, if green and in large quantities, might act as a preventative to overheating and firing. As an assistant, or stimulus, to the vegetable system, it appears, through all the foregoing experiments, to be quite destitute of every good property, and unworthy of notice as a manure in any kind of process.

Such is the opinion of several of the neighbouring farmers who have viewed the different applications, who have, without exception, concurred in this report.

I am, Sir,

your very humble servant,

JOS. FENNA.

Blackhurst,
April 16th, 1798.

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XVIII.

Effect of the Equisetum Palustris *upon Drains. By the Right Hon. Sir* Joseph Banks, *Bart. K. B. President of the Royal Society, &c. &c. &c.*

My dear Sir, Woburn, June 21st. 1798.

During the last very pleasant week we have spent together at the Duke of Bedford's sheep shearing, while you, and the rest of his Grace's guests, were employed in considering and re-considering the merits of the very excellent stock that was daily exhibited to us, I, who am less conversant than most of them in those minute differenees which raise the value of a tup from £50. to £500. employed myself, under the conduct of Mr. Farey, his Grace's steward, in visiting and carefully examining the extensive system of drainage and irrigation, now carring on, by that gentleman upon the Duke's estate.

Few objects of agricultural utility have ever interested me so much, and I have no hesitation in saying that none are, in my opinion, so interesting to the increasing prosperity of the landed intérest of this kingdom, as the theory of draining whole districts, by tapping the mother springs that overflow their surface, and conducting drains through the principal valleys, so contrived as not only to render the boggy parts of them sound land, but also to free the sides of the hills which form them, from all outbursts of water.

Mr. Elkington is certainly the father of this system of drainage, but Mr. Farey has perfectly comprehended all the works done by that gentleman, for the Duke, and in the mode of conducting the operations now carrying on, has, in some instances, excelled them, founding his practice on an extensive and enlightened theory, applicable to all valley bogs, in the drainage of which, it appears to me almost impossible that his method should fail, under any circumstances.

One thing, however, has occurred, in the short experience of the Woburn operations, (about five years), which appears to me of consequence enough to warrant the trouble this will give to you and the Board. Some bogs, drained by under drains made at a great expence through the most miry parts of them, appeared at first perfectly dry, but have since been found to grow by degrees less and less so. On examination, these drains

have been found more or less choked up by a plant vegetating within them, and forming both stems and roots, the whole several yards in length, intercepting the course of the water, weakening the current by degrees, and at last wholly choking up the drain.

This plant is the *equisetum palustre*, a weed common in moorish and swampy places, but hitherto little noticed by Naturalists; its root, or rather its stem under ground, is a yard or more in length, and in size like packthread; from this, a root of twice the size of the stem runs horizontally in the ground, taking its origin from a lower root, which strikes downwards perpendicularly to a depth I have not hitherto been able to trace, as thick as a small finger; this perpendicular root forms in some places beds, which occupy a large portion of the more solid part of a peaty bog, as may be seen in some parts of the banks of the Duke's open drains.

As the bud by which the plant appears to renew itself in spring, is situate on the horizontal root, a yard or more in depth, the shoot must, in its progress upwards, be liable to meet with under drains, and penetrate into them, through the openings left for the passage of the water. When once entered, nature, which has given to the plant the power of piercing the soil upwards from a great depth, enables it to live in the confined atmosphere of a drain, where, as it is continually drawn forward by the current, the joints lengthen themselves beyond their natural dimensions; hence it is probable that when drains choked with it, are taken up and carefully examined, the length of the plants will be found very much to exceed those I have observed.

Had you not asked me for this slight account of a subject I have so imperfectly investigated, I confess I should not have ventured to put it upon paper: I hope, however, that it will lead to further discussion, and shall feel real satisfaction if the end of the discussion shall produce a remedy for this evil, which seems likely to put a total stop to the practice of draining bogs, where this mischievous plant grows, by under drains; it is necessary, however, for the evil to be known, in order that those who possess bogs that have become miry after being drained, may be apprised of an evil, which can certainly be cured by the simple expedient of casting the under drains into open ones.

Believe me, my dear Sir,

with infinite esteem and regard,

most faithfully yours,

To Arthur Young, *Esq. &c. &c. &c.*

Jos. Banks.

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XIX.

ON THE EFFECTS WHICH CARRIAGE WHEELS, WITH RIMS OF DIFFERENT SHAPES, HAVE ON THE ROADS, &c.

[*Mr.* Cumming *having left with the* Secretary *of the Board of Agriculture, for the perusal of Lord* Somerville, *a Copy of his* Essay *on this Subject, it was read at the next Meeting, and so much approved, that the President applied for leave to publish it in the* Communications *to the* Board; *or such part of it, as Mr.* Cumming *might think proper: in answer to which application the following Letter was received.*]

To the Right Hon. Lord Somerville, *President of the Board of Agriculture.*

My Lord,

It is flattering to me that the Essay, which I left for your perusal and observations, meets with your approbation, and is thought worthy of a place among the valuable Communications of the Board of Agriculture.

Although it has been printed for more than two years, it was not my intention to bring it to public view, till it had been submitted to the consideration of Parliament; that, if approved, it might receive that sanction and support, which alone could bring the practice it recommends, into general use, and render it of essential benefit to the public.

But as this Essay can only be considered as the *basis* of a system for the preservation and improvement of roads, private as well as public, I have bestowed much thought, for some time past, on the means that would best answer, to gain all the advantages that might reasonably be expected from a *voluntary* and universal use of cylindrical wheels; but as the attention of Parliament is at this time engaged in matters of such importance, as in a great measure to exclude the consideration of domestic improvements, no attempt has been hitherto made to bring it under discussion.

It was on that account that I declined having this Essay inserted in the last volume

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of the *Communications* to the *Board* of *Agriculture*, with the other Essays on Roads, although the late President applied to me repeatedly for that purpose: but I cannot resist the very polite manner in which your Lordship has proposed to have the whole or part of it inserted in your next volume. The readiness of your Lordship, and the Board at which you preside, to recommend it to the notice of Parliament (if it should be found deserving,) and the attention that such recommendation would receive, cannot be doubted; I therefore most cheerfully agree to have the whole Essay printed with the other Communications to the Board of Agriculture, and shall prepare in a few days a copy for that purpose, with some additional explanatory notes.

It was my wish to write in such plain language as might be understood by men of common understanding, without any great knowledge of science; but I have not the vanity to think, that my success has been such as to render further elucidation unnecessary; I have, therefore, prepared an apparatus, by which every circumstance that is asserted in this Essay is proved experimentally; the different powers required to draw the same load with conical and with cylindrical wheels are shown; the derangement which the conical wheel occasions, in the materials of the road, is rendered obvious to the eye, and undeniable proof given, that the additional power required to draw the same load on conical wheels arises from the partial dragging that unavoidably attends the conical shape of its rim.

If an exhibition of these experiments should be wished for by your Lordship, and any of the Members of the Board, I shall have much pleasure in exhibiting them at your office, at any time which you may please to appoint, giving me one or two days previous notice; and if the result of the experiments should be judged of any importance, the description of the apparatus, and an account of the experiments, may become the subject of another paper, and afford me an additional opportunity of expressing my high respect for the Board of Agriculture, and how much I have the honour to be

Your Lordship's

obedient humble servant,

ALEX. CUMMING.

Pentonville, March 10th. 1799.

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Observations on the Effects which Carriage Wheels, with Rims of different Shapes, have on the Roads; respectfully submitted to the Approbation of the Board of Agriculture, and to the Consideration of the Legislature. By ALEXANDER CUMMING, *Esq. F. R. S. Edin.—(First printed in 1797.)*

TO THE READER.

LATE in the last Session of Parliament (1796), Mr. Cumming had occasion to attend a Committee of the House of Commons, then deliberating on the means of relieving carriages of a certain description from the controul of weighing engines, and subjecting them to an additional toll of fifty per cent. in compensation; and being asked his opinion as to the equivalency of the additional toll proposed, to the damage which the roads might sustain by the exemptions; he stated as his opinion, "that the damage "would chiefly depend on the construction of the wheels that were used; that the "conical or tapering rims now universally used, were extremely destructive; and that "a flat cylindrical rim would be very advantageous to the roads." But being then unprepared, and judging that what he might have to say would be too long for their report, he declined entering more fully upon the subject at that time. But the high respect due to the legislature, and an earnest desire of contributing all in his power to the accommodation of the public, induced him to the investigation that composes the following essay; and if what he has written, should by some be thought too prolix, let it be imputed to a desire of overcoming prejudices established by long and universal usage; by representing the object in various lights.

But seeing as he proceeded that a large field of inquiry presented itself, and that his essay was extending beyond the intended limits; he found it necessary to confine his observations as much as possible to the immediate and contrary effects which the conical and the cylindrical rims of broad wheels must have upon the roads.——In that light therefore, the following essay is offered—not as treating generally of the construction of wheels or wheel carriages, which undertaking would be yet much more extensive.

Although very great advantages may be gained by an immediate adoption of cylindrical rims, more especially to the broad wheels of heavy carriages, yet many regulations will be necessary to extend these advantages to the utmost limits of which

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they are susceptible, and to diffuse the effects of cylindrical rolling, more equally than at present, over the whole surface of the roads.

Much may be done by illustrating, by the most familar means, the several properties and effects of the conical and cylindrical shapes; and contrasting them by simple experiments and ocular demonstration. It will also be necessary that owners of waggons be fully informed of all such matters, and of the privileges and exemptions to which a compliance with such regulations as the wisdom of the legislature may suggest, would entitle them: and that all those employed in building heavy carriages, be made acquainted with the best principles, and most approved construction; by which means, the profound judgment of men of science, and the practical knowledge and dexterity of the artist, may be united for the public good:—and probably a system might be adopted which would not only effectually answer all those purposes, without additional expence to the public, but also produce a considerable yearly saving to the public, and relieve the farmer and the waggoner from inconveniences to which they are at present subjected, to the disadvantage of the public, as well as of themselves.

N. B. The numbers enclosed in parenthesis ( ) refer to the preceding paragraphs on which the subject matter of the present more immediately depends.

Pentonville, 1797. ALEXANDER CUMMING.

OBSERVATIONS, &c. &c.

1. Although the following observations are applicable to wheels of every denomination, they more particularly apply to the broad wheels of waggons, and other heavy carriages, because in them the effect is greater and more perceptible.

2.—The properties of all wheels, so far as regards this inquiry, depend upon their affinity to the cylinder, or to the cone: and in order to shew the nature and tendency of each class, it is necessary briefly to state such properties as unavoidably arise from the shape of these bodies.

3.—THE CYLINDER, having *all its parts of equal diameter*, will, in rolling on its rim, have *an equal velocity at every part of its circumference*, and *necessarily advance in a straight line.*

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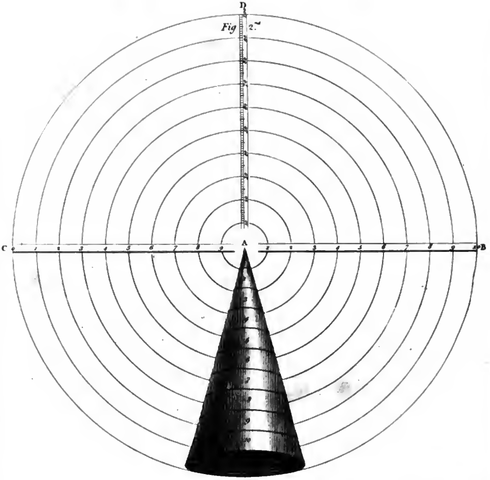
Plate XVIII.

Fig 1st

Fig 2nd



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4.—And as all the parts of the rim have an equal velocity, none can have a tendency to drag forward, or to retard the progress of the others; they all advance with one consent without the rubbing of any part on the surface on which they roll.

5.—As there is no rubbing there can be no friction; and consequently, a cylinder perfectly round, hard, and smooth, would roll on a surface perfectly level, hard, and smooth, *with the least possible resistance*, however great its weight, or the pressure on its rim.

6.—It therefore follows, that all the power that is employed in drawing forward a cylindrical body, in a straight line, on a compressible substance, is ultimately applied in compressing, smoothing, and levelling the substance on which it rolls.

7.—The rolling of a cylindrical body, therefore, (5) can have no tendency to alter the relative situation or position of the parts of materials on which they pass, nor any how to derange them, but by a progressive *dead pressure* to consolidate, level, and smooth them.

8.—And the binding materials over which they pass being thus brought more within the sphere of mutual attraction, and into more perfect contact, are left in a state more favourable to concretion and induration; and, in every respect, better qualified to resist violence, and to protect from rains, the *softer materials* which they cover; and *they* being thus kept dry, are the better enabled to support the crust that protects them: and thus the internal and external parts of the roads derive a mutual advantage.

9.—These proprieties of the cylinder are practically confirmed by the effect which frequent rolling with a cylinder has on gravel walks; it renders them compact, hard, smooth, and impervious to rains; and consequently, secure against the devastations of hard frosts. Nor does it break or grind the gravel, more especially after the first time of rolling, when all the parts are laid flat and smooth.

10.—If a cylinder be cut into several lengths, as represented in Fig. 1, Plate XVIII. each part will possess all the above properties; and if the rim of a carriage-wheel be made exactly of the same shape, it must necessarily have the same tendencies; and its rolling will have the same effect on the roads that cylindrical rollers are observed to have on garden walks.*

* The advantage of increasing the breadth of cylindrical rims are too obvious to be insisted on; as the surface which sustains the pressure of the load is increased, the pressure on each part of it is

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11.—When wheels with *cylindrical rims* are connected by an axis, the tendency of each, being to advance in a direct line, they proceed in this connected state with the same harmony and unity of consent that exist in the parts of the same cylinder; with the same facility of motion (5) so favourable to the cattle; and with all other properties that have been stated as favourable to the roads: *there is no more friction or resistance in this connected state of the pair of wheels* that are applied to the same axis, *than if each rolled separately or unconnectedly.**

12.—*All these properties of the cylinder depending wholly upon the equality of every part of its diameter, and consequently upon the equality of the velocity of every part of its circumference, are peculiar to it; and it is impossible to gain equal advantages with any other shape of the circumference of a wheel.*†

13.—But as *conical rims* have been universally preferred for a series of years, it is natural to suppose that there were obvious reasons for such preference. Let us then endeavour to investigate the properties that must necessarily arise from the shape of the cone; and see from them how far the *consequent effects* can justify the preference so long given to the conical rim.

14.—The Cone diminishing gradually from its base to its point, the velocity of every part of its circumference in rolling on an even plain will be diminished *as the diameter*; and at the very *point*, where there is no visible diameter, there will be no perceptible motion, the cone revolving round *it* as a fixed point or centre; we shall therefore, call it *the conical centre*, to distinguish it from the axis of the cone.‡

15.—Let a cone have races or circles marked on its circumference, dividing the

diminished; and consequently the power of crushing the materials on which they roll: but as it may not be so easy to conceive why increasing the breadth of any wheel should be hurtful to the roads or to the horses, it may be necessary here to observe, that none of the objections that apply to broad *conical* wheels do in any degree apply to broad cylindrical ones.

* The contrast to this will be seen when we consider conical wheels applied to an axis.

† The globular is the only shape that can even in theory advance in a straight line with the same facility that the cylinder does, but the globular form rolling on a flat hard surface, touches only in *a point*; and in rolling on compressible substances, it partakes of the disadvantages of the cone: whereas the cylinder bears equally on the whole breadth of its rim; which gives it superior advantages for the wheels of carriages, to any other possible shape.

‡ In treating of conical wheels, *the conical centre* is only an imaginary point, and must not be mistaken for the centre of the wheel, which is the axis of the cone.

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whole length into ten equal spaces, as represented in Fig. 2; if it be made to roll on a smooth regular horizontal surface, the circles that are on the circumference of the cone will trace on the horizontal surface other circles; also at equal distances; the circumference of each representing the space described by the part of the cone that passes over it in one revolution round the conical centre, and the comparative spaces in any number of revolutions.

16.—But the circumference of each circle is as its distance from the centre, and the velocity of each part of the cone is also as its distance from the centre (14); therefore the space described by each part of the cone in rolling round its point is as the velocity of such part; and the cone will roll *in this direction* without rubbing or friction and with the same facility that the cylinder does in a straight line (5).

17.—But if the cone be made to advance in a straight line, the natural velocities of its several parts will *not* be as the spaces which they are compelled to advance (16); therefore a rubbing and friction will take place at its circumference, from the different velocities of its parts, which must render the draught heavier.

18.—Let a straight line be drawn from the centre of the circles in Fig. 2, to the circumference of the largest, and divided into a number of equal parts, suppose 100, and numbered progressively from the centre, A. to D. Each part of this scale will express the velocity of that part of the cone that rolls immediately over it; and thus may be found the difference of velocity of any two parts of the cone (16).

19.—Example: If the difference of velocity of the greatest and the smallest parts of the circumference of that piece of the cone which is marked No. 10, be desired; the scale shews the velocity of the greatest part to be 100; and of the least part 90: and if each part was to advance according to its natural velocity (16), the greatest would run ten miles whilst the smallest part would only advance nine; which, in fact, happens when they roll round the conical centre;* but, *when made to advance in a straight line*, the smallest part of the rim is necessarily dragged one mile in ten, to keep pace with the largest part. †

* This may be seen by the scale A. B. which shews the comparative spaces described by the different parts of the cone in any number of revolutions round its point or conical centre A.

† If the numbers on the scale A. B. be reversed as at A. C. they will express, in decimals of the whole progress (15), the quantity of dragging at every part of the cone when advancing in a straight line, and rolling according to the natural rotatory velocity of the largest part of it.

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20.—And if the cone be supposed to be cut, and separated at the several races marked on its circumference, and each part to form the rim of a broad wheel; the separated parts will regard their conical centre as when united with the others: and if rolled in this separated state on a level plain, each part of the cone would roll in the same circle round the conical centre that it did when all the parts were connected. And the difference of velocity of the parts of each wheel, and consequently, the friction and resistance at its rim, when advancing in a straight line, may easily be determined. And it will clearly appear that the rubbing at the rim of each, will in passing through a given space be increased as its diameter is diminished (19), and as its breadth is augmented.

21.—Example: In the part of the cone marked 5, the greatest velocity is 50, the least 40; so that with these velocities the larger part of the wheel would advance five miles, whilst the smaller would only advance four (16); but *when moving in a straight line*, the smaller part of the conical rim must necessarily advance as far as the greatest part, and must consequently be dragged *one-fifth of all* the way it goes.

22.—If we take yet a smaller part of the cone, No. 3, its greatest and least velocities are to each other as 40 to 30, or as 4 to 3; so that a wheel of this shape and proportion must have the smallest part of its rim dragged on the surface of the road *one-fourth* of all the way it goes; and daily experience shews how much the *dead drag* of one wheel retards the progress of a carriage; and by analogy, we may judge of the effect of a constant although partial drag, on all the wheels of a heavily loadened waggon.*

23.—But the evil arising from this rubbing at the rim of conical wheels is not confined to the increased labour of the cattle only; the *greatest efficacy is also given to their encreased exertions* in destroying the hardest and most valuable materials of the roads: the largest part of the wheel dragging forward the smallest, and it with equal force resisting, there arises an action and a counter-action, and the largest and the smallest parts of the rim advancing with different velocities, and pressed

* If a waggoner were compelled by any regulation to travel with one wheel constantly dragging, he would willingly pay an ample consideration to set it at liberty. And if he were aware that each conical rim has a constant though partial drag, it cannot be doubted that he would gladly be relieved from this unnecessary labour of his cattle, by altering the shape of the rim, and submitting to such regulation as must ultimately tend to the improvement of the roads, and to his own immediate advantage, by relieving his cattle from unnecessary exertion.

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by the weight of a heavy load, become alternate fulcrums to each other, for the destroying and grinding the hardest materials that can be procured.

24.—Whoever takes the trouble of enquiring into the requisites of a well-constructed pulverising mill, will find them combined in the conical broad wheel of a heavy loaded waggon.

25.—The impalpable powder that is thus formed on the surface of the roads, when in a dry and ridged state, is by the least agitation raised into clouds of dust, to the great annoyance of the traveller, and all who live near the road; to remedy which in some degree, watering is used near the metropolis; which, keeping the roads moist, they more readily admit water, which anticipates and increases the effects of wet seasons.

26.—When the roads are moist, pliant and compressible, the effect of the *conical rim* is altered, but not less destructive: on the approach of wet seasons, the body of pulverised matter that lies upon the more solid gravel which supports the wheels, it soon mixed with water, and forms a body of sludge which excludes air, and keeps the roads in a constant state of moisture: this soon renders the interior parts of the road so moist and pliant, that the pressure of a heavy waggon wheel will make the whole breadth of *its conical rim* to apply flatly; and press hard upon the more solid materials which lie under the sludge; the parts of which being now in a state more susceptible of altering their relative positions, comply with the motion of such parts of the wheel as immediately press upon them; and the relative situations of the parts that form the crust of the road, are as much altered among themselves, as the velocity of the parts of the rim differ from each other (21, 22); and thus, all former concretion is destroyed, induration prevented, and the materials which form the crust of the road are left in a broken unconnected state, ready to imbibe the water which the sludge on its surface supplies constantly and abundantly: and by this means the most destructive effects of wet seasons and subsequent hard frosts are introduced in a manner as destructive and certain, as it is deeply concealed from observation.—How different is this from the consolidating effects of cylindrical rims under the same circumstance?

27.—In rolling on paved streets nothing can be conceived more calculated for their destruction than the *conical rim* of a broad wheel. Let us suppose the *largest* part of the circumference of the broad wheel of a waggon to bear upon one stone of the pavement, and the smallest part of it upon the adjoining

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stone, the one will be pushed backwards and the other dragged forwards (23) by the force of the horses that draw the carriage: and if this force is sufficient to open the joint between them so as to admit water, the mischief is done; a wet joint will imbibe more water; this softens the gravel with which the paving is laid; and leaves it less able to resist the next effort; by which the joint gets more loose, and admits water sufficient to *float* and *discharge the gravel*; which ultimately undermines the paving, and furnishes the surface of the streets with that copious supply of new dirt, which may be seen very soon after it has been completely washed by heavy rains.— This effect of conical wheels acts in so latent a manner, that it appears to have totally escaped notice; *but the cylindrical rim will not only prevent all this mischief, but will also improve the streets*, by producing the effect of the rammer wherever the wheel passes.

28.—Several other disadvantages of less importance attach to the *conical rim*; a constant divergency from the rectilineal direction, makes the wheel to press continually against the linch pin, and ready to fly off the axis when the linch pin is lost or broken (20). The same divergency occasions a twisting of the nave on the axis, which increases friction. And if the *box* is gulled or badly fitted on the axis, it will occasion the hind part of the wheels to run closer to each other, than the front, which makes it rub hard against the *inside** of deep ruts, and throw up much dirt towards the middle of the road, which greatly obstructs the progress of the carriage, and increases the labour of the cattle; none of which inconveniencies attend the cylindrical rim.

29.—It may be thought extraordinary that no good qualities should here have been imputed to the coninal shape of a wheel, although sanctioned by universal preference for so many years; but if any do belong to it, except only the flat bearing of its whole breadth, the Author of this Essay has not been so fortunate as to discover them. He will in a subsequent part attempt to shew the reasons that first introduced them, and that occasioned the preference so long and so unjustly bestowed on them; but it would here divert the attention from what is of more moment to the immediate inquiry.

30.—Let us then, to assist the memory, and to bring the comparative merits of *cylindrical* and *conical rims* into one point of view, briefly recapitulate the properties that *inseparably* belong to *each*: and first of

* *Inside.* Here means the side next the carriage.

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THE CYLINDRICAL RIMS.

31.—1. Naturally advance in a straight line (3);

2. Have no friction or rubbing at the circumference (4, 5);

3. No rubbing against the sides of deep ruts (11, 28);

4. No throwing up of dirt by the hind part of the wheel (11, 28);

5. Do not increase friction on the axis (3);

6. Have no pressure against the linch pin (3);

7. The only resistance to their rolling in a straight line is from compressing, smoothing, and levelling the substances on which they roll (5, 6);

8. They have no tendency to displace, derange, break the texture, or retard the concretion and induration of the parts on which they roll (7);

9. Their frequent rolling on compressible substances renders them more compact, smooth, hard, and impervious to water; and leaves them in a state more favourable to concretion and induration; and by keeping the *interior* and softer parts dry, *they* are the better enabled to resist violence, and to support the crust that protects them (7, 4);

10. They have no tendency to open the joints in paved streets (27); but, on the contrary, to improve them, by producing the effect of ramming the stones on which they pass, by the *dead pressure* produced from the uniform velocity of all the parts (7);

11. And they advance *in a straight course* with the least possible resistance (5), and with advantages superior to any other possible shape (12);

12. They serve equally to improve the roads, to relieve the cattle, and to preserve the tires of the wheels.

And all these properties are as peculiar to and inseparable from the CYLINDRICAL SHAPE as they are favourable to the roads and to the cattle.

CONICAL RIMS.

32.—1. They naturally roll in a circular direction, round their conical centre (14, 20);

2. A constant force is required to confine them to a straight course (17);

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3. When constrained to move in a straight direction, a rubbing and friction take place at the rim (17 to 22);
4. They increase friction on the axis (28);
5 They occasion a rubbing against the sides of deep ruts (28);
6. And a throwing up of dirt from the hind part of the wheel (28);
7. In dry weather they pulverise the best materials (23);
8. Which occasions much sludge in wet seasons, and much dust in dry (26);
9. In a compressible state of the roads they derange and break the texture of the parts, and leave them in a broken state ready to imbibe water, which introduces all the ruinous effects of wet seasons and severe frosts (26);
10. They promote the destruction of paved streets and causeways, by forcibly opening the joints and admitting water under the stones, which ultimately floats and discharges the gravel, loosens the stones, and sinks the pavement into holes (27);
11. They increase the labour of the cattle;
12. And promote the wearing of the tires of the wheels by their constant dragging and grinding on the roads, none of which take place with the cylindrical wheels.

Such are the effects that unavoidably arise from the conical shape, and they seem as much calculated for the destruction of the roads, as those of the cylindrical wheels are for their preservation and improvement.

33.—And, seeing *that the cylindrical rim is the most favourable that can possibly be adopted for the preservation and improvement of the roads* (31), and that *the conical is the most destructive* (33), a certain advantage must be gained by using the former instead of the latter; and as this advantage must be in proportion to the space or surface that is rolled; it cannot be thought excessive to rate that difference at *one shilling for every acre of road that is rolled with an improving roller, instead of an impairing one.*

34.—*Let us then see what may be the probable amount of the advantage that may thus be gained to the nation yearly, by adopting cylindrical rims for the wheels of such waggons only as travel the turnpike roads.*

35.—The number of waggons in England is upwards of 96,600; and supposing that a tenth only of that number, is employed on the turnpike roads, and a fourth

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of that tenth, or a fortieth of the whole, have wheels twelve inches broad; and of the remaining three-fourths, that one half have wheels six inches broad, and the other half, wheels only four inches, the statement of the whole will be as follows:*

36.—	Number of waggons employed on the roads - - -		9,660
	Waggons with 12 inch wheels - - - - - -	2415	
	Ditto with 6 inch wheels - - - - - - -	$3622\frac{1}{2}$	
	Ditto with 4 inch wheels - - - - - - -	$3622\frac{1}{2}$	
			9,660

37.—A wheel 12 inches broad, will, in rolling thirty miles, cover a space of 158,400 feet, and the four wheels of a waggon rolling a double surface will, at the same rate, in a day's journey, roll a surface of 633,600 feet, which is equal to the whole surface of four miles of a road thirty feet wide; and something more than fourteen and a half acres; but rejecting fractions, and taking fourteen and a half acres as the quantity, the result in acres will be as follows:

38.—	2415 waggons, with 12 inch wheels, will, in a day's journey of thirty miles, roll - - - -	35,012
	3622 waggons, with 6 inch wheels, will roll - -	26,259
	3622 waggons, with 4 inch wheels - - - - -	17,506
	The number of acres rolled in a day by all the waggons - - - - - -	78,777

39.—And supposing all the waggons, at an average, to travel only ninety days in the year, they will roll a surface equal to 7,089,930 acres; which, at one shilling per acre, will exceed THREE HUNDRED AND FIFTY THOUSAND POUNDS per annum.

40.—But waving pecuniary estimates; let it be remembered, that the quantity of surface that is rolled once yearly by the waggons that travel the roads of England, is equal to the *entire surface* of 1,948,880 miles of road thirty feet wide (37,38). It is then of importance to enquire, whether the wheels that roll this very extensive surface, tend to improve or to impair it?†

* Allowing 9,660 waggons to travel the turnpike roads, there remains 86,940, of which notice will be taken hereafter.

† It is to be observed, that no notice is here taken of the waggons that are supposed to be employed for the purposes of agriculture, &c. nor of the immense number of carts, coaches, &c. that travel the public roads.

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41.—The sovereign power of prejudice established by long usage, and universal adoption, would forbid an attempt to prove the unfitness of conical rims, if a desire of rendering a public service, and a knowledge of the abilities and dispositions of many members of both houses of parliament to promote improvement, and their unwearied attention to the good and comfort of the public, did not demand it as a duty, and afford every reason to hope that if any thing here offered is deserving their attention, it will receive ample discussion, and that such regulations may be adopted, as will introduce a general and voluntary use of cylindrical broad wheels to all such waggons and carts as travel the turnpike roads: and that may, not only introduce such wheels, but also diffuse the effect of their rolling more equally on every part of the surface; by which means the roads in this country may be improved, without additional expence, and even at an expence greatly diminished, to a degree of perfection much exceeding general expectation.

42.—With a view to remove such prejudices, *we now proceed to shew, that, in the early state of wheel carriages,* CONICAL RIMS *were introduced as matter of accommodation to enlarge the body of the carriage, without any attention to the immediate and destructive effects which they have on the roads.*

It is pleasant to look back and view the primitive state of the roads and carriages in this kingdom, and to trace the gradual improvements which they have undergone within the last half century, and the increase of wealth, comfort, dispatch, and additional time for business, which the inhabitants of the kingdom enjoy from the improvement of the former, and the encreased number of the latter.

43.—SLEDGES probably were the first carriages used; and, as an improvement on them, wheels were applied, to diminish the friction on the surface of the roads.

44.—The first wheels that were applied to carriages were *fixed on the axletree,* which turned with them, so that the axis must necessarily be straight, and the wheels at right angles to it, and parallel to each other; and to give the whole breadth of the rim an equal bearing on a flat surface, *they must necessarily have been cylindrical.*

45.—In remote parts, where many concurring circumstances retard the progress of improvement, these original carriages may yet be seen: and an attentive observation of the primitive state of the roads as well as of the carriages, may throw much light on the subject of this inquiry.

46.—The narrowness of the roads in their early state made it necessary that the

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wheel carriages also should be narrow; and it is more than probable, that the carriages first used were only for the purposes of husbandry, and drawn by one horse.

47.—But in process of time it was found expedient to enlarge the carriages, and to increase the number of horses; but the narrowness of the roads, and the depth of the ruts that were already cut in them, made it necessary that the wheels of the new carriages should run in the tracks of the old.

48.—To gain the advantage of a wider carriage without making the wheels run wider, it became necessary to alter the original construction: the axletree was now fixed immoveably to the body of the carriage, and the wheels made to turn independently of each other on *its ends, which were made to incline, or bend* downwards, by which means the wheels stood wider, or further apart at top than at bottom; and thus room was gained for the body of the carriage without widening the track of the wheels.

49.—The axis being for this reason *bent* (48), and the wheels no longer standing parallel, it was necessary, in order to gain a flat bearing of the whole *rim*, to shelve it off towards the outer edge,* as much as the ends of the axis were bent from the straight line (48); and *thus the rim became conical.* Nor is it probable that any distinction was then made between the flat-bearing of a conical rim, and the flat-bearing of a cylindrical rim of the same breadth.

50.—When the wheels were made to turn on the ends of the axis, it was necessary, in order to get a steady motion of the carriage, to have a longish socket in the centre of the wheel, so fitted as to receive the end of the axis, and to turn on it freely and without shake. This socket is called the nave, and has all the spokes, or radii, inserted in it: the nave is commonly lined with metal, which lining is called the box or bush.

51.—The wheels now diverging at top, the spokes were inserted obliquely into the nave, so as to stand perpendicularly *when directly under the axis*, the better to sustain the weight of the load: and this oblique position of the spokes, giving to the side of the wheel that is the farthest from the carriage, a concave appearance, is called *dishing:* and thus it clearly appears, that the *bending of the axis occasioned both the conical rim* (49) *and the dishing of the wheels* (51); and as both were introduced

* By *outer edge* is here meant the edge of the wheel farthest from the body of the carriage.

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as mere matters of accommodation, adapted to the then existing state of the roads, the narrowness of which demanded a bended axle (49), there is no great reason to believe that the bad qualities of the conical shape, nor the advantages of *dishing*, were originally adverted to.

52.—In process of time it was observed that *dishing* (or the oblique position of the spokes) added much to the strength and stiffness of wheels even with very light timbers; and, on attentive examination, this construction was found to embrace all the properties of an arch.

53.—The bended axis necessarily demanding a conical rim (49) and a dished wheel (51), they were considered as inseparably connected with each other: and the advantages of dishing were considered as peculiar to the conical rim; which circumstance, together with an inattention to the destructive effects which it had upon the roads, have probably been the only reasons of *its* being so long and universally preferred to the cylindrical shape.

54.—But the *dishing* (or oblique position of the spokes) is by no means peculiar to conical wheels, and is equally applicable to cylindrical; and the advantages arising from this arcular construction of the wheel, are in some cases, applicable in a greater degree to cylindrical broad wheels than to conical.

55.—*It does not then appear that any preference is due to the conical rim on account of the advantages that arise from dishing the wheels, since it is equally applicable to cylindrical rims. And, as none of the immediate properties or effects of the conical wheel entitle it to a preference, let us inquire whether there are any concomitant circumstances that can recommend it, or that forbid the use of the* Cylindrical Shape.

56.—The adoption of a cylindrical form will necessarily require a *straight axis* (44), and no other alteration whatever in the construction of the carriage will be necessary. But as the straight axis would make the wheels run equally wide at bottom as at top, the axis must necessarily be longer, and the track of the wheels wider, to preserve the same room for the body of the carriage.

57.—We are therefore to inquire whether, independent of the immediate effect which the rim of the wheels may have on the road, their running wider on it may be hurtful on a more general view of all circumstances?

58.—By making the wheels run further apart on the road, the base on which the carriage stands becomes broader, and consequently it is not so easily overturned: and

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in passing over obstructions, irregularities, or roughness on the roads, the agitation of the *centre of mean resistance* will be diminished, as the distance of the wheels is increased: and the resistance arising from the vis inertiæ; the fatigue of the rider; and the labour of the horses; will be diminished in the same proportion: all which considerations furnish additional motives for preferring the cylindrical wheel and straight axis.*

59.—Having thus totally failed in discovering any one argument in favour of the *conical rim* even from concomitant circumstances, let us endeavour to shew what has so long concealed *its destructive effects* with carriage wheels; more especially as universal preference was given to cylindrical garden rollers.

60.—First, The garden roller being worked by men, and used singly, the difference of the natural tendencies and effect of the cylinder, and of the cone, were more exposed to observation and more easily distinguished, than when a pair of wheels are connected by an axis (64).

Secondly, In drawing the conical roller on a straight walk, its strong bias to deviate from the *straight direction*, and the very considerable and constant exertion necessary to compel it to advance in a straight line, could not possibly pass unnoticed.

61.—Thirdly, The rubbing and grinding of its smallest end, and the much greater exertion necessary to draw forward the conical than the cylindrical roller, must engage the attention of every rational being employed to draw them.

62.—Fourthly, That such has been the case is evident from the constant

* Much depends on a thorough understanding of this principle in the construction of wheel carriages, especially those for dispatch; and in constructing and loading ships. And there are not wanting instances where, from a want of due attention to this principle, one half of the effect in mechanical operations is totally lost, and the labour doubled.—The centre of mean resistance in carriages and in navigable vessels is nearly allied to the centre of oscillation in pendulums; but involves more considerations; and the application of this principle to wheel carriages would, in some instances, appear to be directly contrary to what it is in nautical concerns. In wheel carriages all deviations of the *centre of mean resistance* from the line of direct progress, are either horizontal or vertical, or compounded of both.—Deviations generally increase resistance; but in some instances vertical deviations may be promoted to advantage, but the horizontal never; and every circumstance that tends to prevent or diminish them is advantageous in the construction: attending to this circumstance alone, low wheels and long axles should be preferred; and the centre of gravity of the load should be kept as low as circumstances will permit; this will diminish the agitation, render the draught lighter, and the carriage more secure against overturning.

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and universal preference given to the cylindrical garden roller, even for circular walks, where a *conical* roller would have been preferable.

And FIFTHLY, although the conical roller demands much more force to draw it forward, it never leaves the surface so close, compact, and smooth, as the cylinder does; the smaller end of the cone rubbing and dragging on the surface leaves it rough, loose, and unconnected. All which circumstances could not possibly escape the notice of the most ignorant or inattentive person whose bodily exertions were employed in drawing them, and whose attention was directed to their effect.*

63.—It might be thought that the superiority of the cylindrical over the conical garden roller, might lead to an investigation of the comparative merits and effects of the cylindrical and conical wheels of carriages, but *the following circumstance has probably prevented it; by concealing from observation in wheel carriages, the real and natural tendency of the conical rim, and consequently its destructive effects.*†

64.—When *a pair of conical wheels* are applied to the opposite ends of an axis, they advance in a straight direction; APPARENTLY with the same ease and tendency that cylindrical wheels do (11). But how deceiving is this appearance, may be seen by an attentive perusal of what is said from paragraph 15 to paragraph 23; each wheel constantly endeavouring to roll round its conical centre; the one drawing to the right, and the other, with equal force, drawing to the left; they exactly counteract each other, and are thus compelled to advance in a straight line. But although this rectilineal progress *appears to be natural and spontaneous*, it is quite the reverse;—

* The improving qualities of the cylinder are much more obvious than the destructive effects of the cone, which, in a great measure accounts for the universal preference given to the former for garden rollers, and the readiness with which the latter shape was used to the wheels of carriages, when it was found convenient to have a bended axis (49).

† The use of rollers in moving large timbers, blocks of stone and marble, &c. is of very great antiquity; and these rollers being made of round pieces of timber, were naturally cylindrical, and this being the best shape in most cases, was used on all occasions.—When friction rollers were applied in machinery to remove or diminish friction, the cylindrical shape was universally used, and in many cases where the conical shape was more proper. It is more than forty years since I laid down rules for ascertaining the most advantageous shape for *friction rollers* under all possible circumstances, so as to have no rubbing or friction at their rim, and to move with the least possible resistance. But although the same principle applied equally to the rims of carriage wheels, as to friction rollers, it did not at that time occur to me, to be of so much importance to the public as it now does, the object of my pursuits at that time being totally different.

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the natural tendency which so powerfully presses itself on the notice of him that draws the single conical roller (60), is here concealed by the intervention of the axis.—The two conical wheels counteract the divergency of each other; but the *destructive effect of each wheel on the roads, and its resistance to the draught, is in no degree diminished*, although deeply concealed from observation.—*And these reasons seem to account sufficiently for the evils arising from the conical rims having so long escaped detection*: for, if waggons, like garden rollers, had been drawn by men, the encreased exertion required with the conical rim, even on the best and smoothest roads, would soon have engaged their attention, and independent of all other considerations would have procured to the *cylindrical carriage wheel*, that preference which was so justly bestowed on the cylindrical garden roller.

65.—But it may be necessary to add some further reasons for being of opinion, that the bad effects of conical rims were either totally unobserved, or have remained without due investigation.

66.—The strongest argument that has been offered for continuing the bended axis is, " That when the axis is straight, the lower side of its conical ends act " in the nave or " box of the wheel, as on an inclined plane, which gives it a constant tendency to press " against the linch pin, and to throw the wheel off the axis."—The remedy proposed, was " to *make* the axis so, that the *under side* of its conical ends shall lie in a straight ho- " rizontal line."—This necessarily demands a bended axle and a conical rim, and plainly proves that they were nor aware of the divergency and rubbing that unavoidably arises from the conical rim. For thus, *by bending the axis there is a necessity of making the conical rim* (49); and the conical rim, unavoidably occasions a strong and constant pressure against the linch pin (64), so that in attempting to remedy a small imperfection originating at the centre, they not only increase the very imperfection which they meant to remove; namely, the pressure against the linch pin, but also add another, and much greater evil, at the circumference of the wheel (22); which cannot be removed *by any possible means* but by rendering the axis straight, and the rim cylindrical.—This demonstrably proves, that the tendencies and effects of the conical shape were not attended to by the advocates for the bended axis, which necessarily introduces the conical rim.

67.—Another strong ground for believing that none of the bad effects which attend the conical wheels have been attended to, arises from the great mechanical skill and heavy expences, that have been wasted in removing or diminishing the friction on the

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axles of wheel carriages; which when compared with the friction at the circumference of the conical wheel, is totally undeserving of notice, from the very trifling comparative resistance which it occasions; and surely if the greater evil had been discovered, it would have claimed a priority of cure.

68.—And, moreover, the natural friction on the axis may be much abated by the application of oil, grease, &c. but there is no possible remedy for the friction, trituration, and increase of resistance that unavoidably take place at the conical rim, but by substituting *the cylindrical.*—All which concurring circumstances, it is presumed, may justify the assertion, that the cylindrical and conical rims have been indiscriminately used, without attention to any properties that are peculiar to either (and that so very strongly distinguish them); always preferring that rim which admitted of a flat bearing of the whole breadth of the wheel under the existing circumstances (44); and consequently when the *axis* was straight, the rim was cylindrical; and with the bended axis the rim was necessarily conical (49) to give it an equal bearing on its whole breadth.

69.—It appears then, that in searching for arguments in favour of the conical wheels, we meet with nothing but additional reasons for preferring the cylindrical; and as the bent axis and conical rims were first used on account of the narrowness of the roads (48, 49), there can be no reason, at this time, for continuing the use of them for such carriages as travel the turnpike road only.—And the advantages which must result from the use of cylindrical wheels to them alone, will be more numerous and extensive than they have hitherto been stated (58), arising from considerations that are not within the scope of our present inquiry.*

70.—In the preceding estimate (39) no allowance was made for such waggons as are used in agriculture, and that seldom come upon the public roads: but as every improvement of the private as well as public roads, must be a national benefit, we shall now consider what advantage may be gained on the private roads by the same means.

71.—Eighty-six thousand nine hundred and forty waggons are supposed to be employed for the purposes of agriculture (35), which is nine times the number that we have

* Nothing can be of greater advantage to the roads, than the diffusing the traffick of carriages equally on every part of its surface; this can never happen on convex (or barrelled) roads. On them, *all carriages* keep on the very summit, which by that means is soon cut into ruts, that retain the water, and prevent its running down the sides as was intended; and by that means, the only purpose for making the roads convex is not only frustrated, but perverted.

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supposed to use the turnpike roads (35); but as they do not keep constantly even upon the private roads, we shall suppose them to travel the roads only one day in a month, at which rate they will, *cæteris paribus*, roll one-ninth more surface than all the waggons that travel the public roads, at the rate of eight days in the month; but let us suppose it only equal.

72.—The quantity of surface that would be rolled once in the year, by all the waggons travelling the turnpike roads in England, is equal to the entire surface of 1,948,880 miles of a road thirty feet wide (40), and taking an equal quantity for the private roads (71), the whole surface that is rolled yearly by waggon wheels on the public and private roads together, if uniformly diffused, would cover every part of the surface of 3,897,760 miles of road thirty feet wide; and in proportion as the length of road on which this traffic is supposed to be carried on is shortened, so much the oftener would it be rolled.

73.—The circumference of the terraqueous globe is computed at 24,900 miles, and if a road 30 feet broad was made quite round it, the waggons that travel the roads of England, would yearly roll every part of its surface 150 times (72); and,

74.—Supposing *two* such roads made close to each other, and in every respect similar, as to formation, materials, exposures, &c. &c. but that the one is rolled by cylindrical, and the other by conical wheels, 75 times in the year, the former will be rendered more compact, close and impervious to water, each time of rolling; and in the end will be so solid and hard, and its surface so close and smooth, and so free from dust in summer, and from sludge in winter, as neither to admit, nor to lodge water; which is the most effectual means possible of guarding against the destructive influence of wet seasons and severe frosts (31), and consequently of keeping the roads in continual good repair, at the least expence.

75.—But the *other road*, being rolled also 75 times, *but with conical wheels*, they will in dry seasons pulverise and destroy the best materials intended for the protection of the roads (23); and in wet seasons they alter the arrangement, and destroy the texture of the component parts of the crust, and leave them in a broken unconnected state, ready to imbibe water (26), which is constantly supplied by the sludge on the surface; which also effectually excludes the sun and air; and thus the roads become rotten, and break into holes and ruts; and if a rainy autumn is succeeded by

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severe frosts, they will raze to the foundation every part into which the water and frost have penetrated.

76.—Let any man of observation, who has had an opportunity of attending to the nature and repair of roads, and the expences attending such repairs, seriously consider all the above circumstances, and make his own estimate, of the number of men; quantity of new materials; and extent of labour and expence that would be yearly necessary, but more especially after a wet autumn and severe winter, to restore that road that had been rolled by conical wheels (32), to an equal state with the road that was rolled with cylindrical wheels (31), and he will, probably, make his estimate to exceed any that has been here stated (39).*

77.—It is also to be observed, that the latter road will not only be much more expensive than the former, but is liable for some months in the year to be in a state very disagreeable, and even dangerous to the traveller; and very destructive to the cattle; and at no time so pleasant as the road that is rolled with the cylindrical wheels; on account of the dust in summer (23), and the deep sludge in winter (26). And the draught of carriages upon it is at all times, but more especially after repairs, much heavier than upon *that road, which remains always unimpaired.*†

* When cylindrical and conical wheels are promiscuously used on the same road, their effects are so blended that it is impossible to distinguish or separate them. But if two similar pieces of road were made, and conical wheels only were allowed to travel the one, and cylindrical wheels the other; the difference of the two roads would soon prove the different effects of the cylinder, and of the cone; and the extent of the advantage that must arise to the public, by adopting the former, and rejecting the latter.

† It has been observed, that after very heavy rains, and where running waters have accidentally covered the surface of the roads, they were consolidated and improved thereby. This introduced the practice of washing roads, where running water can be procured, which is found very beneficial; but daily experience shews the advantage of removing sludge by other means, where running waters cannot be procured; and, although several reasons might be offered, why sludge is more penetrating and hurtful to the roads than pure water, such enquiry being foreign to our present subject, it is sufficient for our purpose that daily experience and observation confirm the fact. If then, the removal of sludge from off the roads be so advantageous, surely any means by which its formation and accumulation may be prevented or diminished would be yet more advantageous than washing; and this can best be effected by discontinuing the use of conical wheels; which will diminish the dust in summer, the sludge in winter, and save the most valuable materials that incrust and protect the

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78.—When the advantages of cylindrical wheels are fully proved and universally known, there is no doubt, that thin, light, smooth rims, truly cylindrical, and broader than are now used, will be adopted universally for carriages of pleasure and dispatch, as well as for those of burthen; which, considering the immense number of carts, coaches, &c. &c. &c. in this kingdom, will add greatly to the advantages already stated: and the saving, that must arise in the repairs of *private roads*, from the use of broad cylindrical wheels, will very soon repay the first expence of making them of a sufficient breadth to admit carriages of any dimensions, which will totally obviate the only reason that now exists for using a bended axis and conical rim (46 to 49), and pave the way for an universal adoption of a straight axle and cylindrical wheel.

79.—The author of this essay is conscious that more is already said than is necessary, to enable men of extensive information and quick conception to form their judgment; and although he is aware, that the success of this attempt will wholly depend on their opinion, example, and support, he is nevertheless anxious to convince others, who are more immediately interested, but whose opportunities and capacities are more limited.—It will not be denied, that rolling with heavy cylindrical rollers would even in the first instance much improve the roads; but the expence attending this operation would exceed all resasonable bounds.—Let us then inquire, to what degree this end may be accomplished, without additional labour or expence?

80.—If the breadth of cylindrical wheels, and the length of the axles are made to bear a regular proportion to the number of draught horses; and the fore-wheels to run narrower than the hind, so as to roll a double surface, the roads formed flat; and proper regulations are made for quartering the roads; every waggon might be made as effectually to improve that part of the road on which it rolls, as if the horses had been

roads, as well as diminish the labour of the horses. In order to give an idea of the consumption of pit ballast used on the roads near the metropolis, the following statement is offered:

On an average of seven years, 10,961 loads of ballast have been annually laid on the roads belonging to the Hampstead and Highgate trust; and, as nearly as can be conjectured from observation, an equal quantity of sludge, or pulverised ballast, has been yearly removed:—from this circumstance, some idea may be formed of the importance of using every possible means for preventing this immense consumption of materials, which must in a few years increase in price, as they become more scarce, and the carriage of them more distant. The expence of each load of ballast laid on this road is from 5 to 6*s*. exclusive of labour in laying it, &c. The length of road in this trust is nearly 20 miles, so that the quantity of ballast at an average is 548 loads per mile annually.

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employed for that only purpose. It is true that the rollers in this case are not so broad as might be desirable for that only purpose, but if the effect is not so extensive, it is more dense and compressive; and if the roads are made so nearly flat that carriages may with equal conveniency drive on every part of them, they will be more equally traversed, and more uniformly improved than at present; the destructive effects of the conical wheel will be evaded; and the draught of the horses made much easier.

Let us now see what sum would pay for the labour of the horses that may thus be made to roll the roads gratis, if they were employed for the only purpose of rolling them?

82.—The number of waggons supposed to travel the turnpike roads is 9,660, and allowing three horses at an average, for each waggon, their number will be 28,980; and taking an equal number for those waggons that use the private roads (72), the whole number will be 57,960; and supposing them to be employed only 90 days in the year, at 4s. per day for each horse, it would amount YEARLY to upwards of ONE MILLION STERLING; and it ought to be considered, that although the labour of the cattle is greater the first time of drawing on a new tract, that it becomes light the next time; and if each individual contributes his aid, by once rolling on a new part of the road, all the others are contributing equally to improve the road for him; and his good office is thus repaid, more than a thousand fold, by others who roll the roads for him.

83.—It is not meant to assert, that any of the estimates here offered are correct: but it is hoped they prove that in every point of view, the object is of such magnitude and importance as to claim attentive investigation; and if what has here been advanced is found to merit the notice of those to whom it is addressed, Mr. CUMMING *will consider himself as peculiarly fortunate in having suggested an improvement, from which, every individual in the kingdom may derive accommodation, without additional expence to any; and by which, ultimately, a very considerable yearly saving and advantage may be gained to the public.*

POSTSCRIPT.

In the foregoing essay, the conclusions are drawn from facts, and practical observations only. The author of it was for many years, in the earlier part of life, in the habit of reading all publications on subjects of this nature, and all others relative to mechanical and philosophical improvements; but of late years he has seldom found the

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information which he could glean from compilations, to compensate for the drudgery of reading them; for this reason, he has for several years past, seldom read periodical publications; and if any thing relative to the subject of the foregoing essay has been published in that way, or in any other, it has escaped his notice; but he will thankfully receive any information on the subject, that can lead to improvement.

APPENDIX.

In the preceding essay the effects of such wheels only, as have *an equal bearing of their whole breadth* have been considered, as all the laws that have been made for regulating the breadth of wheels, by the weight of the loaded carriage, have supposed and intended that all wheels should have; but as various means have been devised to evade these wise regulations of the legislature, by using wheels *that have* NOT *an equal bearing of their whole breadth*, the object of the following observations, is to shew in what manner such wheels as bear on a narrow part only of a broad rim, operate to the destruction of the roads, and to the manifest disadvantage of those who persist in using them.

PRELIMINARY OBSERVATIONS.

1. If earth, sand, gravel, or any other material, or combination of materials, of which roads are usually made, be laid on a flat pavement to the depth of some inches, and confined at the sides, so as to be of a regular and equal breadth and depth, and of some considerable length; if the boards, or other substance by which the sides are confined be removed, and a flat wheel of the whole breadth of the bed or stratum of materials be made to roll on it length-ways, the pressure of the wheel will not only consolidate such parts as remain immediately under its track, but will also distend and spread a part of the materials to each side of the wheel, when it meets with no lateral

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no rate of toll can compensate the damage which they do the roads; and it is to be remembered, that in all cases, the *immediate* increase of exertion required of the cattle, is in proportion to the damage done to the roads; and every heavy carriage with wheels of this description, that travels the roads, renders it worse for him that follows: how much then would it be the interest of *all* to use no other wheels, than those that improve the roads?

6. We now come to apply these preliminary observations in determining the most advantageous form of a road (so far only as regards the effect of carriages upon them). As such ample information on this point, and every other matter regarding the laying out, making, repairing, and managing roads, have been given in the several communications to the Board of Agriculture, by Mr. Beatson of Kilrie, Mr. Wright of Chelsea, Mr. Jessop, Mr. Holt, Mr. Joseph Wilks, and Mr. J. F. Erskine of Mar, as would preclude any further observations on the subject, did not an earnest desire of contributing to so important an object of public improvement demand every exertion, and supersede every other consideration.

7. *Convex or barrelled Roads* have been generally preferred; *First*, because they are supposed to lie drier than flat roads, from the declivity on each side, giving a greater current to the water, than could be obtained if carried in the direction of the road; and, *Secondly*, as its *external form* resembles an arch, it is supposed to partake of the same property of sustaining pressure better than any other form; but it must be remembered, that if the abutments that sustain the lateral pressure, and prevent the extention of the best constructed arch, give way, it will no longer sustain its own weight. If then, the convex road be less calculated to resist the *lateral pressure* already described, (4); and to prevent the extention, or spreading of the materials, it can derive no advantage from its apparent affinity to an arch. The advantage of carrying off the water towards the sides is obvious when the roads are just finished, and have their surface of that perfect smooth form which the theory always supposes them to have; but so soon as any ruts are formed, they obstruct the running of the water *towards the sides*, and retain, or conduct it longitudinally on the road, contrary to the original intention; and as no proper means have been used in forming the roads to carry of the water from those ruts, it remains in them, and is mixed deeper and deeper with the materials of the road by every wheel that passes, till at last the hard protecting crust is worn through, and the wheels penetrate to the soft materials of which the road was originally formed, and deep holes are thus made, which, by the constant passing of all car-

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riages in the same track, are enlarged into dangerous gulphs; and all those evils arise from the convex form, which obliges all carriages to drive on the very highest part only; and thus the imaginary advantages of convex roads vanish in practice, and in the place of advantages we meet with evils of the most formidable nature.

8. When the crown of the convex road is rendered impassible by the constant traffick of all carriages in the same track, if any are compelled to travel on the declivities on either side, the wheels force the hard materials down the sides, (their own weight, and the tremulous concussions of the roads, occasioned by the passing of heavy carriages, also promoting the descent;) the best materials of the convex road are insensibly shifted from the middle to the sides; from the only part of the road constantly frequented, to the extremities, where they can be of no service.

9. *Flat Roads that are level from side to side*, are much more pleasant to travel than the convex; every part of the whole breadth being equally convenient, is equally frequented, and equally worn, and there being no such declivities, as on the sides of convex roads, the materials have no tendency to shift from the spot on which they are laid (8); no deep ruts are formed, because the road is equally traversed, and the traffick of carriages equally and voluntarily diffused over every part of its surface, and the track of every wheel however shallow, becomes a small channel or drain to conduct the water along the road, in which direction it was intended to flow, provision being accordingly made to gain a proper current, and to carry the water off the road by shallow channels across it, at proper and convenient distances: and here it is to be observed, that as each carriage takes its own course, there being neither rut nor declivity to prevent it, every carriage making new channels to carry the water from the surface of the flat road length-ways, the more carriages that pass the sooner will the roads get dry; and thus the *frequency of carriages* passing on a *flat road* in rainy seasons has a tendency to keep it dry, and in that respect to improve it; whereas, on a convex road, the frequent passage of carriages tends to its immediate destruction (7); and whoever takes the trouble of observing how the water runs longitudinally in the ruts on a convex road, although the declivity down the sides be incomparably greater than in the direction which it is compelled to take in the ruts, will soon see the propriety of constructing roads so as to have the water run length-ways, upon them, instead of attempting to gain a declivity, by making it run from the middle to the sides.

It may here be enquired, since the water is found to take a longitudinal direction on the convex road, as well as on the flat road, what additional advantage can be

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gained, in this respect, by abandoning the convex form in favour of any other? To this it may be answered, that when it is intended to make the water run longitudinally on the road, every advantage is taken for this purpose in the original conducting and formation of the road, which is often neglected when the theoretical advantages of convex roads are admitted; and, by avoiding the convex form, we avoid all the disadvantages inseparably connected with it (7), and may gain every advantage that belongs to any other form that may be preferred. But, taking for granted, that the same declivity is longitudinally maintained on the convex as on the flat road, the advantages that must be gained by preferring *the flat* to the *barelled form*, may be collected from what has been said under each of these heads, all which give a decided preference to the FLAT, over the CONVEX form.

10. *Concave Roads.* Let us suppose a strong trunk, or channel of wood or stone, having its whole length of an equal breadth, and filled several inches in depth with any binding materials, such as are used in making roads, and moistened to such degree as may promote their uniting and cohering. If a heavy cylindrical roller of the whole breath of the channel be made several times to pass on it, the materials not being able to escape sideways from the pressure of the roller, all its force is applied perpendicularly in compressing, consolidating, and bringing the parts into closer contact, and within the sphere of mutual attraction; and as the repeated rolling with the cylindrical wheel cannot in such case promote lateral motion, after the materials have been once compressed, nor any how alter the relative situation of the parts, nor break the texture or retard the induration by any internal relative motion of the parts, the materials will at last become so compact, and *incompressible*, and so rigid, smooth, and close, that the wheel will roll on them with the same facility as on wood, stone, or iron, and if always kept dry, might be almost equal to the best waggon way; but if the resistance to the *lateral action* be taken away, the materials retreating somewhat sideways every time the wheel passes, they can never become so compact and close as when the lateral motion is wholly prevented, and the whole pressure is applied perpendicularly, and when the relative position of the materials are never changed, nor their connection broken.

11. This serves only to shew the necessity of having all roads well bounded with walls, banks, or some other means of firmly resisting the tendency to spread, by the lateral pressure of the wheels that pass upon them; for if the parts of the road have a power of extention, the constant internal relative motion of the parts, however slow or imperceptible, will, by sometimes pressing the one way, sometimes

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the other, ever prevent induration, and that complete degree of consolidation and *impenetrability* which might otherwise be obtained by the traffic of heavy carriages with broad cylindrical wheels. But admitting that a road be consolidated to the greatest degree of perfection, if wheels of the destructive shape described (4) be used with a heavy loaded waggon, they would penetrate its surface, and force the materials to each side; and by the frequent passing of such wheels, the surface must be divided, and the materials broken and disunited to a considerable depth, so as to admit water, which introduces every other means of devastation; and every wheel that has only a partial bearing on the rim belongs to this destructive class.

12. *Roads that are level in the middle* of a sufficient space for all carriages to drive on, and have an additional space on each side, sloping towards the middle, so as to join the level carriage road, serving to lay on materials from which the *carriage way* is easily supplied, and at the same time serving as an abutment on each side, against the extention and lateral pressure of the materials, and having ditches or drains on the field side of those sloping parts, to intercept springs, and to keep those sloping parts or abutments always dry and rigidly immoveable, may, from every consideration, be reckoned the best construction, having every advantage of the flat road, with the addition of better abutments against the lateral extension, and other effects of such internal relative motion of the materials as may take place by the pressure of a heavy carriage on this, or on that side; for however imperceptible such effects may be, it cannot be doubted that they retard, in a considerable degree, the consolidation, induration, and union of the whole mass.

13. Thus far I have been led, contrary to my intention, to consider the comparative advantages of the different forms of a road, *so far only* as they regard the effects which wheels of different shapes have upon them, and the fitness of each form to resist the effects of such improper shape, and in the hope of shewing the necessity of legislative authority, in preventing the use of any other broad wheels, than such as are truly cylindrical, with a smooth flat rim, and the heads of nails level with the tire.

It can scarcely be supposed that any carter, or waggoner, would prefer a road that was covered with small pebbles fixed to the surface, to a road that was quite level and smooth; yet we frequently see his cart wheel of an immense size and weight, having its rim garnished all round with two or three rows of nails, the head of each projecting above the tire at least three-fourths of an inch. Surely, if the owner of such cart and horses was aware that these projections on the rim of his wheels obstruct the

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progress of his horses on the best and hardest roads, and even upon the hardest pavement, as much as pebbles of the same size, fixed at the same distance, on the surface of the roads would retard them, they would entirely discontinue this absurd and ruinous practice.

14. The damage that is done to the roads by locking the wheel of a heavy loaded waggon in going down hill, deserves serious attention; for in dry sesons, this rubbing of the locked wheel crushes the best materials to atoms, and in wet seasons it ploughs up the roads; for whatever may be the steepness of the descent, the rubbing and resistance of the locked wheel will always be the same, and when the declivity is gentle, there is sometimes as much or more exertion required to drag the carriage down hill, as would draw it on level ground when the wheel was unlocked. It would therefore be very desirable, if, to avoid these evils, any other means could be devised of checking the rapidity of heavy carriages in coming down hill, *by a resistance proportioned to the declivity.*

15. Some months since, having occasion to wait on the *Lord Chancellor* on the subject, be shewed me a drawing of a two wheel cart, in which this was effected in a manner that appeared to me equally new, simple, and judicious. On enquiring, I was told that *it was Lord Somerville's invention*, and wishing to mention a matter that was so intimately connected with the subject on which my attention was then bent, and that bad so long baffled all the attempts of ingenuity, I wated on his Lordship, and he most politely assented to my mentioning it in any degree that I might judge most likely to render it useful to the public, or to elucidate any part of the subject which I was then endeavouring to investigate.

16. The *first* thing that attracted my attention in this neat light cart, was a method, equally simple and expeditious, of adjusting the centre of gravity of the load, so as to have a proper bearing on the horse in going down hill, the advantage of which must be obvious to every man of science, more especially with bulky loads, in which the centre of gravity lies high.

17. The next thing, and what was more immediately interesting to me, was a method of applying friction to the side of the wheel, to regulate the motion of the carriage in going down hill, (instead of locking the wheels) the advantages of which method appear to be as follows, viz.

18. *First*, The pressure and degree of friction may with great expedition be adjusted to the steepness of the declivity, so that the carriage shall neither press forward, nor require much exertion to make it follow the cattle.

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19. *Secondly,* The friction is with great propriety so applied to the wheel, that a *given* pressure will have *twice* the effect in retarding the progress, that it would have if immediately applied to the body of the carriage, or to the axis: and by applying the friction on both sides of the wheel, the risk of heating and destroying the friction bar is much less than if the same degree of friction was applied in one place.

20. *Thirdly,* This apparatus is so conveniently placed, that it can be instantly applied or adjusted, without stopping the carriage, or exposing the driver to the same danger as in locking a wheel.

21. And *fourthly,* This useful contrivance, in which simplicity and ingenuity are so happily blended, will assume yet greater importance, when applied to *both* the hind wheels of waggons, by which means the resistance may always be proportioned to the steepness of the descent, the tearing up of the road prevented, the unneeessary exertion of the cattle in drawing the *locked carriage* down hill avoided, the danger to which the driver is sometimes exposed in locking the waggon wheel totally evaded, and the time now lost in locking and unlocking the wheel, saved.

22. I thought it best here to mention only the general principle and properties of this useful improvement, in hopes that the attempts of different men of genius to obtain the same end may be productive of different constructions, from some of which, useful hints or immediate advantages may be gained, that might be prevented by giving a more particular description in the first instance. I do not know whether this cart has yet been tried, but there cannot exist a doubt of the effect of the mechanical contrivance; the only doubt with me is, whether the constant rubbing of the wheel in descending a long declivity may not generate a degree of heat, that may occasion ignition; but if ever this should happen, some means may be discovered hereafter to avoid it, and it may always be prevented by a careful driver.

23. Before turnpike roads were so generally established in this country, immoveable obstacles were frequently met with in travelling, to be surmounted by carriages before they could pass. This induced men of science to compute the power necessary to draw a loaded carriage, by the force required to draw it over such obstacles; and as this force was less with high wheels than with lower ones, it appears to have been inferred generally, that the resistance to the progress of a carriage on level roads also, is diminished in the same proportion by enlarging the wheels; and this doctrine in favour of high wheels is maintained by some without limitation, or regard to concomitant circumstances.

24. But we ought to examine, whether in practice there may not be something

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to counterbalance this imaginary advantage, when the wheel exceeds a certain size, and whether some disadvantage does not *accompany* the high, wheel that may *increase* the resistance to the progress with the height of the wheel?

25. On turnpike roads, no such obstacles as these alluded to are now to be met with; they are all removed in making the roads; and the resistance to the progress of a carriage, although arising from a variety of mixed causes, is rendered much more uniform, and subject to laws very different from those, by which the resistance of a fixed obstacle to a wheel passing over it, is estimated. The advantages therefore, which high wheels have in surmounting fixed obstacles, vanish when there are no such obstacles to be surmounted.

26. But another advantage yet attends high wheels, even in the improved state of the roads. A high wheel makes fewer revolutions in advancing the same space than a small wheels does; the friction therefore on its axis is less in proportion, as its revolutions are fewer; but although this friction has by some been considered as the greatest resistance to be overcome in drawing a carriage on a well made level road, it does in fact bear no sensible proportion to the resistance at the circumference of the wheel, especially with conical rims.

27. *The opposition of gravity in going up hill* is by much the greatest resistance to be overcome on good roads. If then we compare the addition made to *this resistance* by the immense weight of the hind wheels of a large waggon, we shall find it to exceed the whole friction on the axis, out of all proportion; and thus we see, that by using very large wheels much more power may be lost, by adding to the weight, than is gained by the diminution of friction: and although it may be difficult to ascertain the very best height of wheels, under all possible variety of circumstances, it may be best for all carriages of heavy burthen, and that require much strength, to keep the height of wheels within moderate limits, which limits may be much better ascertained by judicious experiments and local circumstances, than by thoretic demonstration.

28. To shew the impropriety of estimating the total resistance to the progress of a carriage, by the force required to draw its wheel over fixed obstacles, it is only necessary to observe, that this mode of estimating is applicable only to such resistances as suddenly raise the centre of gravity of the loaded carriage before it can pass; but all such resistances as are not sufficiently great to elevate the centre of gravity of the

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load, or that have no tendency to raise it, must be estimated by laws arising out of the nature and circumstances of each separate resistance.

29. The several resistances that conspire to retard the progress of a wheel carriage, so far as they occur to me at present, are,

1*st*. The innate force, or inactivity of matter.

2*d*. The opposition of gravity in gradual ascents.

3*d*. The opposition of gravity in getting over fixed obstacles.

4*th*. The friction in the axis.

5*th*. The friction, or partial dragging, at the rim of all wheels that are not truly cylindrical.

6*th*. The resistance to the rim in passing through sludge, or any other such substance, that is partly fluid and non-elastic.

7*th*. The resistance in compressing non-elastic substances that have no degree of fluidity.

8*th*. The resistance of substances that have a degree of elasticity, by which they partly recover their position when the wheel has passed, but not sufficiently strong to raise the centre of gravity of the carriage.

9*thly* and *lastly*. The tenacity or cohesive attraction of substances that adhere to the wheel, such as clay.

30. From a due attention to the very different nature of each of these resistances from each other, the impropriety of estimating the whole, by one general rule, must be evident. All that art can accomplish in so complicated a case is, by attending to the nature of each resistance separately; its causes, and the laws by which it resists: is, *to construct carriages that may be the least liable to each resistance, considered separately*; by which means, we may be assured of meeting with the least possible resistance from the whole combined, in all the variety of changes and fluctuations that can happen among them, from the different circumstances of the roads, and of the seasons in the longest journey.

31. In discussing matters of science, I have ever thought that he who is convinced of his mistake, gains the greatest victory; when he corrects an error of judgment, or overcomes a rooted prejudice, he subdues a dangerous enemy, and constant attendant; he is ever after the wiser man, and the more valuable member of society; and

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ought rather to be proud of having discovered and corrected, than ashamed of having committed the error.—I shall always consider him as a friend who enables me to correct any mistakes which may have escaped me in the preceding observations; but no regard will be paid to criticisms that have no tendency to improvement, or to public benefit.

Pentonville, March, 1799. ALEXANDER CUMMING.

THE BOARD *having seen* Mr. CUMMING'*s experiments, and resolved to make similar experiments with loaded waggons of full size with those that he had exhibited with models, applied to him to give the necessary instructions for preparing the apparatus at the Society's expence,—in answer to which, is the following letter:*

MY LORD,

ON a full consideration of the idea of an apparatus to draw a loaded waggon, of the common size, by a weight, I am inclined to think that the experiments would not give the expected satisfaction. The largeness of the weight necessary to draw the waggon, and the shortness of the space which it could be drawn by such an apparatus, would render the experiments made in that way less satisfactory than those made with models, in which the revolutions of the wheels being much more numerous, the difference in the effect with the conical wheels will be more perceptible.

I am well aware, that a suspicion and diffidence may arise in the mind of many sensible persons, who may learn the result of the experiments which have been made at the Board; and who have not seen the experiments and the apparatus with which they were made, or been fully informed of the nature and intent of the conclusions to be drawn from them. But I have that opinion of the sagacity and good sense of the waggon-owners in and near the metropolis, that leaves me no doubt of being able to satisfy the majority of those who may attend the experiments on any future occasion; and when the more sensible and ingenious part are convinced, their example will soon induce the others to adopt what, possibly they might not have sufficient penetration to see the advantage of, without such inducement. But if, after these gentlemen have seen the experiments, any farther proof of the advantages of the cylindrical wheel

should be deemed necessary, to convince them that the conclusions are well founded, and that all the disadvantages that are stated in the Essay and the Appendix, take place in practice, as well as in theory, with every wheel that is not truly cylindrical, I shall always be ready to give any assistance, of which I am capable, in removing their doubts.

If, however, the subject of the public roads of the kingdom should become a matter of legislative investigation, and render a minute experimental proof of every circumstance necessary, I shall be prepared to offer such further experiments and proofs, as will meet every objection, and remove every doubt. But I am inclined to think, that after all that can be done to convince or persuade, that the evil will not be wholly removed without extensive parliamentary regulations.

I trust however, that your Lordship and the Board will believe my readiness to give every assistance in the present stage of the business, as well as to arrange such ideas as may occur to me, as necessary to the accomplishment of all the advantages that may be gained to the public from a proper system of regulation and management in a business to which my attention has for some years been much directed: and although I have not the vanity to hope, that I can succeed in maturing such a system, the crude ideas that may occur to me, regarding the evils to be remedied, may at least have a tendency to lead others more immediately to the remedy.

I have the honour to remain, with great respect,

Your Lordship's

Obedient,

Humble servant,

Pentonville, April 17, 1799. ALEXANDER CUMMING.

Rt. Hon. LORD SOMERVILLE.

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Board of Agriculture, Sackville Street,
26th April, 1799.

Sir,

By the resolution of the Board of Agriculture, you will perceive that we are making advances in the very useful path which you have traced out. It was thought by some members of the Board, that the experiments here mentioned for the world at large, in addition to your own, for persons of scientific education, would tend to disseminate that conviction, which cannot fail of being useful to the public.—Will you have the goodness to undertake this commission, which I am sure cannot be given to any person more able to perform it, to the satisfaction of every party.

I remain,

Your obedient servant,

Somerville, *President.*

Alexander Cumming, Esq.
Pentonville.

Extract from the Minutes of the Board of Agriculture, 23d April, 1799.

" In consequence of the notice given of a motion by the Earl of Winchilsea, that an " experiment be made with waggons at large, to ascertain the comparative advantages or " disadvantages of conical or cylindrical wheels, and an axle tree to suit them, for com- " parison with the same waggon and the same load, but with conical axles and wheels, " Resolved that such experiments be made, and that Mr. Cumming be requested to " procure the wheels and axles at the expence of the Board, taking every precau- " tion that the wheels shall be of the same diameter and weight, and the axles of the " same mean diameter, with such other attentions as his mechanical abilities may " suggest; and that such experiment be made on Thursday the 30th of May on the " road beyond Kennington, in the way to Streatham, at eleven o'clock in the fore- " noon, and that notice be given to waggon-owners, and trustees of the turnpike roads " near London."

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My Lord, *Pentonville, Sunday, April 28, 1799.*

I am this moment honoured with your Lordship's letter, accompanied with the extract from the minutes of the Board of Agriculture, of date the 23d.

It is very flattering to me, that your Lordship and the other members of the Board have judged those ideas and experiments which I had the honour of offering to their consideration, so far deserving notice, as to determine them to have an experiment, similar to those which I made in miniature, tried with a loaded waggon of the full size.

I shall ever be ready to exert my utmost endeavours in complying with the desires of the Board, in this, or any other matter that can tend to promote their patriotic views of public improvement, or to overcome deep rooted prejudice. I shall with pleasure undertake the ordering and giving directions for completing the waggon for the intended experiment, but would be glad to state some matters to the honourable Board, before the time for trying the experiment was finally settled or advertised, to prevent any disappointment that might happen by unforeseen delay from the workmen employed: I also wish to have a further communication with your Lordship and the Board, previous to the making the waggon, in order that I may be enabled the better to meet their ideas and wishes in the intended experiment; for although the general principle and object cannot be mistaken, one mode of making the experiment may be more satisfactory than another; and it is my wish to adopt that mode which may be the most consistent with the ideas of the Board:—I wish it to be particularly decided, whether the wheels of the intended waggon should be of the sizes now used, or of that which may, upon farther investigation, be judged the most proper for general use; upon the idea that the very large size of the hind wheels of waggons, as now made, adds more to the labour of the cattle by the increased weight of the wheel, than is gained by the diminution of friction on the axis; and whether, to render the difference of the resistance at the rim of conical and cylindrical wheels of equal size the more perceptible, any extraordinary means should be used to diminish the friction on the axles, by using the best *oil-boxes*.

I must confess, that if my best endeavours of eradicating vulgar prejudice was to be exerted without the aid of such powerful and very respectable authority, as the

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Board of Agriculture, I would introduce this as a *final experiment*, and shew to some more members of the Board, who have not yet seen them, the experiments on the models, with explanatory observations on the principal object of the experiments; and the conclusions which are meant to be drawn from the result of them: for however great the advantage may be to the draught of cattle, by preferring the cylindrical wheel, *the chief object is the improvement of the roads*; and to impress more fully the many circumstances that lead to these ultimate conclusions, even on the mind of those who are above all prejudice, the experiments and observations should be repeated, and as many objections stated, as may occur to those who attend: it is my wish to meet every objection from those, whose only motive in stating them, is to ascertain the truth; if unable to satisfy them, I certainly am not ripe to encounter public prejudice; if able to satisfy the more judicious and discerning, I shall disregard the opinion of the less intelligent.

I have the honour to remain,

Your Lordship's

Obedient,

Humble servant,

Rt. Hon. Lord Somerville. ALEXANDER CUMMING.

The Board having resolved, on the 23d of April, to make a public experiment with large waggons on the 30th of May, on the road beyond Kennington, applied to Mr. Cumming to order the broad wheels and other requisites for the experiments, which occasioned the following letter:

My Lord, *Pentonville, May 4, 1799.*

In consequence of what passed at the Board of Agriculture on Tuesday, I have applied to two different wheelers to know in what time they could undertake to make the wheels and axles for the experiment which was proposed on the road near Kennington; neither of them could fix any certain time in which they could be done: they say, that all those large wheels are made in the country; that the timber must be cut out for them

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the tree; that there was scarce any chance of getting in London, timber of proper dimensions for making two sets of wheels sixteen inches broad, without making the felloes in two breadths; this would not only prolong the time, but also enhance the expence. I asked them, if they could be finished in the manner which they proposed, in a month? they said, " Not in two;" and on being questioned whether they might be depended on in two months, they said they could not be certain, for the reasons already assigned.

Knowing that when the London tradesmen are employed in any work with which they are unaccustomed, their expences and charge are commonly very high, I made enquiry on that head also, but neither would state his opinion as to the expence, or nearly what they thought it would amount to. I then asked each (separately) what would be the expence of such a waggon with one set of wheels only, and without the tilt or any of the upper parts above the body of the waggon? the answer was, " Not " less than a hundred guineas." From all which circumstances I thought it improper to give any orders before those circumstances were submitted to the Board.

I am also decidedly of opinion, that other experiments may be made at a less expence, that will tend more immediately and more effectually to overcome prejudice, than the experiment proposed, with wheels that bear only on a part of the breadth of their felloes, and drawn by horses. Since the result of such experiment depends in a great measure upon the nature of the materials of which that part of the road is composed, upon which the experiment is made, and upon the state of moisture and dryness of the materials for some thickness from the surface, a great variety of such circumstances may occur that may very much affect the result of the experiment, although they cannot be discovered by viewing the surface of the road: should any unfavourable circumstance of this kind happen, it might tend to confirm, instead of removing, the prejudice which it was meant to combat. I am clearly of opinion with Lord Winchilsea, that an experiment should ultimately be made with two loaded waggons of equal weight, or with one waggon having occasionally cylindrical, or conical wheels put upon the same axis, * and having the breadth of their rims, and their respective diameters, as equal to each other as possible; an experiment made with such wheels having an equal bearing on the whole breadth of their rim will be decisive, as to the comparative merit of each class of wheels.

With regard to broad wheels that bear on a narrow part only of their breadth, I

* This axis must be susceptible of an adjustment hitherto unattended to, to make it fit for receiving the cylindrical and the conical wheels, so as to give each a flat bearing on a level surface.

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had stated in the Appendix, which I had the honour of submitting to your Lordship and the Board, a case in which they would be drawn with the least possible resistance; that is, with as little resistance as a cylindrical wheel, (see paragraph 4 of the Appendix); and this circumstance may take place, in part at least, from the nature and state of the materials of which the *unknown* road is composed, and which cannot be discovered by inspecting the surface. I must confess that there appears to me to be some risk in making an experiment with wheels that may be thus affected by causes that are invisible to us, and consequently not generally adverted to, and with wheels that have been invented to evade the salutary operation of the laws which were intended to enforce the use of wheels *whose rims have an equal bearing of their whole breadth*, and whose breadth should be proportioned to the weight of the loaded carriage. Should any circumstance of the nature above alluded to, happen to occur in the proposed experiment with the broad wheel having a narrow bearing, before other means are used to *conquer prejudice*, that *task* may become yet more difficult from the accidental result of an experiment affected by invisible causes:—nor does the experience and success, which I have already had, leave me room to doubt, that by proceeding on the plan which I have proposed, I shall be able to convince at least *nine-tenths* of all the farmers and waggoners, who shall take the trouble of attending the experiments which I may hereafter have an opportunity of making at the Board. Of this I had a pleasing instance on Wednesday: When one of the wheelers already alluded to, called upon me, a gentleman farmer from near Canterbury, of the name of *Hill*, was with me; desirous of seeing my experiments, I invited the wheeler also to see them; and on producing both my carriages, and asking their opinions which would be drawn with least force, that with the conical, or the one with the cylindrical wheels? they both without the least hesitation declared in favour of the conical wheels: I then asked, whether they thought the conical wheel that was straight across the felloe, or that which was rounded at bottom, the best? and they both declared in favour of the rounded bottom, saying, that it certainly *went lighter*.

I then made my declaration in favour of the cylindrical wheel, and proceeded to experiment; but both were so suspicious of deception, that each examined separately the motion of each wheel on the axis, least any of them should have been screwed tight to prevent the freedom of its motion. When both were perfectly satisfied in that respect, and the waggon loaded, they wished to know if the whole breadth of the conical and of the cylindrical wheels applied equally flat to the road. They again declared

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in favour of the conical wheels, and expressed their surprise in strong terms, when they saw the great difference in favour of the cylindrical. They again examined the wheels, yet suspecting that the conical had not the same freedom of motion with the cylindrical; and when they were fully satisfied in that respect, the same experiment was repeated, with the same result, and the same astonishment was again expressed.

With the experiment to prove that the superior resistance with the conical wheel was owing to the different velocities and dragging or rubbing of its rim, they seemed as much pleased as they were surprised at the first, and had the candour to declare, that they never had the least conception of any such resistance; nor that there existed any such cause of resistance at the circumference of the conical wheel, any more than at the rim of the cylindrical wheel; but were then fully satisfied as to the existence of the resistance with the conical wheel, and of the cause from which it arose.

I then observed to them, the derangement which the conical rim occasioned in the materials of roads, and the destructive effects of that derangement, by admitting water through the crust of the road. At this discovery, *Mr. Hill* (the farmer) seemed greatly pleased, and exclaimed, *that although he had been the surveyor of the roads for near twenty years, that he never had thought of that.*

I now began to think that I had completely converted them, and the more so, because they had discovered a proper degree of diffidence and suspicion at first, and in the end declared themselves fully convinced; but when I mentioned the conical wheel with the *high tire in the middle*, I found that I had yet difficulties to overcome, which could not have been accomplished without the preceding experiments and explanations, to prepare the mind by degrees to yield to the conviction of reason.

The *wheeler* insisted, that the wheel having a high tire in the middle, certainly went lighter, than when its whole breadth pressed equally on the surface of the roads; and the gentleman farmer yet thought that the cylindrical wheels would go better when *a little* rounded across the felloe, than if quite flat; because, he said, that if quite flat the whole breadth, it would cut the road quite square at the corners of the wheel; but on calling to their recollection, that the resistance at the rim of the conical wheel was owing to the different velocities of the parts of its rim, and that every wheel that was not truly cylindrical, and consequently truly flat on its whole breadth, must have a different degree of velocity in the several parts of its rim, and consequently partake of the destructive effects of the cone. Having thus satisfied them in the first instance, that the resistance of the conical wheel was owing to the different velocity of its parts,

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the transition from the cone to any other irregular shape becomes easier, and I was enabled to effect that conviction which it would have been vain to have attempted without such previous steps.—I have to apologise for this too long letter; and have the honour to remain with great respect,

Your Lordship's

Obedient humble servant,

The Rt. Hon.
LORD SOMERVILLE.

ALEXANDER CUMMING.

Short Account of EXPERIMENTS *on Broad-wheeled Carriages, exhibited before the Board of Agriculture, on the 18th day of March, and on the 30th of May, 1799, by* ALEXANDER CUMMING, *Esq. F. R. S. Edin.*

ADVERTISEMENT.

As many may be disposed to suspect the accuracy of experiments, the result of which are in several instances, so contrary to general expectation as the following are, it was thought necessary to give a short description of the apparatus with which they were made; that others, who may incline to try the same, or similar experiments, may prepare an apparatus, with which the same result may reasonably be expected; for any alteration in the apparatus might occasion a different result with the experiment. If, for example, any person was to try the experiment, N° 7, with a carriage having its hind wheels larger than the fore wheels, (as is usual in all four-wheeled carriages) the result would always be different from what is here stated; because the hind and the fore wheels, rolling on the same friction bars, would counteract each other, and be liable to give a different result every time the experiment was repeated, according as the load pressed more upon the hind, or upon the fore wheels.

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Whoever takes the trouble of making himself intimately acquainted with the principles laid down in the preceding essay, may anticipate the effect of every experiment that can be made, under all possible variety of circumstances: and he who is not so completely master of it, as to *recollect*, as well as to understand every part and reference, will always be liable to misconception, and to draw erroneous conclusions from his experiments; and as the number and variety of experiments that might be suggested, for ascertaining the best construction of *wheel carriages*, are endless, Mr. CUMMING has offered only what appear to him as *leading ones*, having a direct tendency to prove the superiority of the cylindrical shape, and to contrast it with the ruinous effects of the conical; and it will afford him much pleasure to find that others should have recourse to such farther experiments and investigations, as may be necessary to convince themselves where his endeavours may have failed. He wishes to recommend nothing but what will stand the test of accurate experiment and sound reason; and it will always be pleasing to him, to see every part of what he has advanced minutely scrutinized; nor will he ever be ashamed to acknowledge any mistake, which he may have made, nor backward in answering any objections that may be stated, if candidly and fairly urged.

N.B. The power required to draw the loaded carriage, in these experiments, will vary, according as the waggon-way may be more or less inclined to the horizon. The experiments here stated, were made on a dead level, and repeated on different days, three several times on each day, with the same result each time.

DESCRIPTION OF THE APPARATUS.

THE APPARATUS with which, these experiments were made, consisted of two models of waggons, each of which, with its wheels and axles complete, weighed four pounds; and with a leaden weight that was occasionally used (as a load) to either, the loaded waggon weighed thirty pounds.

Cylindrical Wheels.

(1.) The one waggon had *cylindrical wheels*, $2\frac{1}{4}$ inches broad in the rim, and $4\frac{1}{4}$ in diameter: the rims of all the wheels and the surface on which they rolled, were covered with one thickness of fine woollen cloth, to give an uniform resistance, like that of dust

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or sludge on the roads, and that all the parts of the whole breadth of the wheels might, with the greater certainty, touch, and bear equally upon every part of the surface over which they were drawn.

Axles.

(2.) The axles were made of steel, and the parts that act in the boxes were truly turned, and about $\frac{5}{16}$ of an inch in diametor. They work in brass bushes or boxes, $2\frac{1}{4}$ inches long, and all of them were opened with the same implement, exactly to the same width; so that the axles being fitted to them, must all be of the same size with each other: they were very little tapered, and touched the bushes only about half an inch at each end.

Conical Wheels.

(3.) The breadth or flat bearing of the rim of the *conical wheels* was the same as that of the cylindrical, ($2\frac{1}{4}$ inches,) their greatest diameter, $4\frac{5}{8}$ inches; the least, $3\frac{7}{8}$ inches; difference of the greatest and the least diameters $\frac{3}{4}$ inch; the mean diameter $4\frac{1}{4}$ inches, (equal to the diameter of the cylindrical wheels); the *inside* * of the wheels in both carriages were distant from each other 5 inches, so that both carriages roll on the same track, and every part of the *whole breadth* of each wheel was carefully made to apply equally to the flat surface which it rolled.

(4.) *The path* or *way* on which the carriages were drawn, by means of weights suspended by a fine silk line, was of sufficient breadth for the carriages to roll upon, and seven feet long. Each *carriage* was ten inches long; and the immediate action of the descending weight draws the carriage forward four feet only, so that a space of two feet is left, *for the carriage occasionally to advance, after the descending weights have done acting upon it.*

Scale of Acceleration, how constructed.

(5.) By comparing the space which the carriage advances, after the *weights* have done acting upon it, with the space in which they acted, we discover how much the acting power was greater than the resistance to the progress of the carriage during the time of their acting: thus, if ten weights, descending a given height, are capable of

* By *inside* is meant the side nearest the carriage.

drawing the loaded carriage a given space, one of these weights in descending the same height, will draw the carriage one-tenth of that space :—let the space which the carriage is made to advance by the immediate action of the descending weights, be divided into ten equal parts, and, it is evident, that one-tenth of the power, that draws the carriage the whole space, will be required to draw it one of those divisions, (a tenth of the whole space); and if those divisions are continued forward, from where the descending weights have done acting, (which we here call the point of rest) the number of spaces which the carriage advances beyond this point, by the velocity which it had acquired, will shew how much the resistance to the progress of the carriage is less than the acting power; every space or division on this scale, which the carriage advances, after the weights have done acting upon it, being equal in value to a tenth of the weight or power by which the carriage was drawn.—If the resistance to the draught be just equal to the power by which the carriage is drawn, it will stop the instant the weights have ceased acting upon it; but if we find the carriage advance one space on *the scale of acceleration*, (i. e. one space past the point of rest), we conclude that the resistance is one-tenth less than the power; if it advances two spaces, the resistance is to the acting power, as 8 to 10, &c. The numbers in column C of the following table of experiments, refer to this scale, and shew the number of spaces which the loaded waggon advances by its *innate force* (or velocity acquired), when the weights have done acting upon it.

The Fore Wheels and the Hind Weels of equal size.

(6). It is here to be particularly noticed, that the fore and the hind wheels, in each model, or carriage, must be exactly of the same size, otherwise the experiments with the friction bars will not succeed: if the fore and hind conical wheels were of different diameters, as is usual in four wheeled carriages, they would have different degrees of rubbing at their rims; and when the hind and the fore wheels roll on the same friction bar, the smaller wheel having a greater tendency to give it motion than the larger wheel, they would counteract each other, and give a result very erroneous; and different to what is stated in the following experiments.

The Experiment with the Conical Wheels shews only half of the true Derangment.

(7.) It is also to be observed, that the derangment of the materials that is shewn in the *seventh* experiment, represents only *half the damage* that is done to the roads by

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deranging and breaking the connection of the parts that form its crust; for either the hind, or the fore wheels alone, that roll on the same bars, would give the same motion to the bars that both the wheels give it; but when they act separately and independently, (as they do on the roads), each will have a *separate effect* in destroying the texture and cohesion of the materials, equal to what is exhibited in the experiment, by *the united action* of the hind and fore wheels together.

(8.) And if the fore and the hind wheels, in the model, (with the conical wheels) were made to roll a double surface, the fore and the hind wheels would *each* exhibit as much motion of the friction bars, as they both do when they roll on the same surface, as in the following experiments.

The Weights that draw the Carriage.

(9.) The loaded waggon, *with the conical wheels*, being placed on its path or waggon-way, a fine silk line was applied to draw it forward, and to this line, (after passing over a pulley) was suspended a thin bag or purse, into which was poured small lead shot, just sufficient to draw the loaded waggon, and to begin its own motion: which weight being divided into ten* equal parts, each of them is supposed to represent one degree, (or one-tenth,) of the whole power; and according to the number of these small weights that are required to draw the loaded waggon under different circumstances, the comparative resistances to its progress are determined.

Nature of the Experiments.

(10.) This apparatus is furnished with different long slips of wood covered with cloth, in those parts only on which the wheels are intended to bear; so that by changing those slips, the wheels may be made to bear on their whole breadth, on the middle only, or on the extremities of the rim; and by making the conical and the cylindrical wheels to be drawn with the same load, on those different slips, in their turn, *the comparative forces that are required to draw the same load on each kind of wheel, under all the variety of circumstances that can occur, may be ascertained experimentally, with sufficient accuracy to determine which principle should be preferred.*

* The ten weights, which together draw the loaded carriage on conical wheels, are equal to a 24th part of the load; and each weight separately, is equal to a 240th part of the weight of the loaded carriage; and by this means, the proportion which the power that draws the carriage bears to the weight of the loaded carriage, may in all cases be found.

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Use of the Part of the Apparatus hitherto described.

(11) This part of the apparatus serves only to ascertain *the comparative degrees of power that are necessary to draw the same load*, under all the different circumstances that may occur in practice, and may be considered as regarding only the *labour of cattle.*—The following part of the apparatus is to represent to sight, and to prove to our senses, the different effects which the *conical* and the *cylindrical* wheels have on the roads; the one in destroying, the other in improving them.

Friction Bars.

(12.) Besides the slips of wood already mentioned (10), there is another *set* of narrow wooden bars, laid longitudinally and collaterally, so as to form one even surface for the wheels of the carriages to roll upon; these bars are covered with cloth also, and each slip or bar is supported by a set of friction pullies, so as to move independently of each other, and with very little friction: seven of these bars lie under the breadth of one wheel, which is made to press equally on each of them; and the friction bars may be fixed, or set at liberty, at pleasure.*

Their Effect in the Experiment.

(13.) *When the friction bars are at liberty*, they move easily on the friction rollers, (12), and when *a conical* wheel is made to roll upon them, (the parts of whose rim necessarily have different velocities,) each bar will comply with the velocity of that part of the wheel that presses upon it; and the different motions of the bars will exhibit to view that difference of motion, or velocity of the several parts of the wheel, that occasions

* To render the relative motion of the friction bars more evident, and to represent the derangement that takes place in the materials of the roads the better, these friction bars are covered with striped cloth (the stripes laid across the road); and when the bars are fixed in their places, the stripes of the cloth join, so as to appear as one entire piece, but when made to move by the rolling of the conical wheels upon them, the derangment of the materials on the road is naturally represented by the relative motion of the contiguous stripes of the cloth.—In all the *preceding experiments*, this part of the apparatus is concealed by a piece of cloth of one colour, stretched tight over the surface of the friction bars, which gives the waggon-way the appearance and effect of one entire piece, or solid bed, for the wheels to roll upon.

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the dragging and increase of resistance to the progress of the carriage ;—and by fixing these friction bars, or setting them at liberty, occasionally, the friction or rubbing on the rim of the wheel that rolls upon them, may be removed, or restored at pleasure ; and by that means, *its resisting effects* may be separated from all others, its existence distinctly proved, and its quantity accurately ascertained in all possible cases.

Destructive Effects of Conical Wheels on the Roads.

(14.) And by this means also, the destructive effects which this difference in the velocity of the parts of the conical wheels have, in pulverising, breaking, and opening the *protecting crust or surface* of the road, is more convincingly exhibited, and brought more within the comprehension of all capacities, than could be done by lines and demonstration only ; and what is here said of the *conical wheel*, is applicable also in some degree to every other possible shape of a rim *that is not perfectly cylindrical.*

EXPERIMENTS WITH THE CONICAL WHEELS.

EXPERIMENT FIRST.

(15.) The loaded carriage *upon conical wheels, having the whole breadth of its wheels flatly applied to the road,* was drawn by 9 weights.

EXPERIMENT SECOND.

(16.) The same loaded carriage, *with its wheels bearing on a fourth part only of their breadth,* was drawn by 6 weights.

OBSERVATION *on the 1st and 2d Experiments.*

(17.) If a conclusion were drawn from the result of these two experiments, it would be, that the *resistance* must always be diminished by narrowing the bearing of the wheel ; and increased, by making the *flat bearing* of the wheel, broader : and it would seem as if *this resistance was inseparable from a flat broad rim.*

(18.) OBSERVATION 2d. The preceding conclusion appears so consistent with the general opinion, founded on extensive experience, and attentive observation, that all further enquiry into the cause of this increase of resistance with the broad wheel was totally suspended, as vain and fruitless : and the hire tire on the middle of the wheel was

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universally adopted by the waggoner, as the only means of removing that increase of resistance, which was found to take place with the flat rim bearing equally on its whole breadth, and which was considered as *inseparably connected* with that flat bearing of the whole breadth.

EXPERIMENT THIRD.

(19.) *The same loaded waggon*, and wheels, bearing only on *two slipes or tires at the extremities of the rim*, which together were in breadth only equal to $\frac{1}{3}$ of the breadth of the wheel, was drawn by 11 weights.

OBSERVATION *on a Comparison of the 1st and 3d Experiment.*

(20.) Here we see the resistance to the progress of the carriage *increased* by *narrowing* the bearing of the wheel :—when the whole breadth of the wheel pressed equally on the road, the carriage was drawn by 9 weights as in Exp. 1. but in Exp. 3, altho' the bearing is reduced to $\frac{1}{3}$ of the whole breadth, the resistance is increased, and 11 weights are required to draw the same load, that in the 1st Exp. was drawn by 9, and in the 2d, by 6 weights.

OBSERVATION 2d. How repugnant is this to the conclusion that must have been drawn from a comparison of the *first* and *second* experiments only? (17, 18.) This experiment proves, that the resistance to the progress of the carriage, and consequently the labour of the cattle, may be *increased*, by making the bearing of the wheels on the road narrower; but the 2d experiment proves, that the resistance and labour of the cattle may be *diminished* by making the bearing of the wheel narrower.

(21.) OBSERVATION 3d. And the joint evidence of these, seemingly repugnant results, proves, That the resistance to the progress of the carriage does not depend altogether on the breadth of the wheel, nor on the flat bearing of the whole rim of a broad wheel; if it did, that resistance must always be increased or diminished, as the part of the rim that bears upon the road was broader or narrower; but this does not happen, for in the 2d experiment, the resistance is diminished from 9 to 6, by making the bearing of the wheel narrower; but in the 3d experiment we see the resistance increased from 9 to 11, by reducing the bearings of the same wheel to one third of its breadth. We must, therefore, examine more minutely, to discover the *true cause* of this fluctuation in the resistance, for it cannot possibly depend upon the

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breadth of the wheel, or of that part of the wheel which bears the pressure of the load.

22. OBSERVATION 4th. The greatest *difference of the velocity* being at the extremities of the *conical rim*, that is, at the largest and the smallest parts of the wheel, the *largest part*, if detached from the smallest, would advance in each revolution further than the smaller; but being connected together, the largest part cannot advance without the smallest, which must be constantly dragged forward on the road, a space equal to what it would fall behind the largest in a separated state in an equal number of revolutions; this consideration alone would fully account for the resistance in the 3d experiment being *equal* to the resistance in the 1st;—but the resistance is *greater* in the 3d than in the 1st experiment; because, the pressure of all the load is in the 3d experiment, thrown wholly on the extreme parts of the rim, where the difference of velocity of the parts and the resistance of this dragging, necessarily become greater, as the weight and pressure on the part or parts that are dragged is increased.

23. OBSERVATION 5th. In the 1st experiment, the pressure is diffused on the whole breadth of the wheel, so that the extreme parts sustain only a third of it:—in the 3d experiment, the whole pressure is confined to the extremities of the rim, where it becomes more intense as the supporting surface is narrower; and owing to this increased intensity of the pressure on those parts of the wheel where the dragging is the greatest, the resistance to the progress of the carriage is greater in the 3d, than in the 1st experiment, in the proportion of 11 to 9.

24. OBSERVATION 6th. And this consideration totally removes all the apparent disagreement between the 2d and 3d experiments: it opens a new field of enquiry; fully accounts for the unexpected result of the 3d experiment, and shews the danger of adopting apparent causes for the real, without recourse to some certain criterion by which they may be distinguished.*

* On some future occasion, if health and leisure permit, I may possibly offer some observations, and state some cases of much importance, where the mistaking the apparent cause for the real, has led to conclusions very erroneous and unfavourable to improvement. That nothing can be more unfavourable to the progress of improvement, and the investigation of truth, than the imputing an effect to a wrong cause, is evident in the present subject of investigation; where the having imputed the greater resistance, which was found to take place with broad wheels to the breadth of the wheel, instead of imputing it to the different velocity of the parts of the rim, has stifled all enquiry, and concealed from notice for more than half a century, the destructive effects of the conical shape of carriage wheels, and has cost the nation some millions of money in the useless labour of cattle, and extra expences of repairing roads; all which must have been avoided by imputing the resistance in the first instance to the true cause.

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EXPERIMENTS WITH CYLINDRICAL WHEELS.

EXPERIMENT FOURTH.

25. *The loaded carriage on cylindrical wheels, with the whole breadth of the wheels bearing on the road*, (as in Exp. 1st.) was drawn by 6 weights.

EXPERIMENT FIFTH.

26. *The same loaded carriage and wheels*, with the wheels rolling on slips of $\frac{1}{4}$ *their* breadth, (as in Exp. 2d.) was drawn by 6 weights.

EXPERIMENT SIXTH.

27. *The same loaded carriage, its wheels rolling on two slips, at the opposite extremities of their rims, and bearing only on a third part of their breadth*, (as in Exp. 3d.) was drawn by 6 weights.

OBSERVATIONS *on the 4th, 5th, and 6th Experiments.*

28. *First*, By comparing these three experiments, we see that the resistance to the progress of the carriage on cylindrical wheels, (so far as appears by the number of weights that are required to put the *loaded carriage* in motion) is nearly the same, whether the wheels have a bearing of their *whole breadth* (as in Exp. 4th.);

Or when the wheels bear on a narrow part of the *middle* only (as in Exp. 5th.);

Or when the wheels roll on two narrow parts at the opposite extremities of their rim, (as in Exp. 6th.)

29. *Second*, That the same variety of circumstances, which occasioned a difference of 5 weights, (or degrees of power) with conical wheels, (as in Exp. 1st, 2d, and 3d.) did not, by the number of weights, shew any such difference with the cylindrical wheels, (as appears by Exp. 4th, 5th, and 6th.)

30. *Third*, But although no difference of resistance appears by the number of weights that were required to put the loaded carriage, on cylindrical wheels in motion; it appears by the number of spaces which the carriage advances, in each experiment, after the descending weights had done acting, (see column C.), that the *resistance* to the progress of the carriage was the least, when the bearing of the wheels was the broadest; as will appear more fully, when the use of the scale of acceleration is explained.*

* This scale had not been applied to the apparatus, nor thought of, when the experiments were

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The following Experiments are intended to shew the very different Effects which the conical and the cylindrical Wheels have on the Roads, and are particularly recommended to the Notice of the Trustees of Turnpike Roads, as well as to those who are interested in the Use of broad Wheels.

31. The same carriages that were used in the former experiments, are used in the following also; but they are now drawn upon a path-way that is composed of narrow wooden bars, of the whole length of the frame, supported on *friction rollers*, (13), which bars being *set at liberty*, remove nearly the whole friction from the circumference of the wheels; and when the *bars are fixed*, the friction at the rim is again restored.

N. B. The breadth of each wheel covers seven friction bars, and presses equally on each.

EXPERIMENT SEVENTH.

32. The loaded carriage, with *conical wheels*, their whole breadth bearing equally on the friction bars (13), (now *at liberty*), and the friction by that means being removed from the rim, was drawn by 6 weights.

OBSERVATION *on the 7th Experiment.*

33. In this experiment, each of the narrow bars, on which the wheels were drawn, is moved with ease on the friction rollers, and each bar complying with the motion of that part of the wheel that pressed upon it, the difference of the velocities of the several parts of the wheel is thus transferred to the bars; and the relative motions of

made before the Board of Agriculture; and from an attentive comparison of the experiments that have been made with the conical wheels, (the 1st, 2d, and 3d,) with those similar ones that were made with the cylindrical wheels, (the 4th, 5th, and 6th,) it will clearly appear, that the increased resistance, which has hitherto been found to take place with broad wheels, was NOT owing to the *breadth*, but to the *conical shape* of the wheels; and that by making the rim of *carriage wheels* of a true cylindrical form, their breadth may be increased, and the whole breadth have an equal flat bearing on the road, without increasing the resistance to the progress of the carriage, but, on the contrary, that the labour of the cattle will be diminished by increasing the breadth of the wheels.

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the bars represent the difference of the velocities of the parts of the rim that pressed upon each; and exhibits also the manner in which the materials of the roads are disunited, and broken, by every conical wheel wherever it rolls, and as often as it rolls in the same place.—This experiment also proves past all dispute, that the increased resistance with the *broad conical wheel*, arises from the different velocity of the several parts of the rim, and the dragging and rubbing occasioned thereby, (as fully explained in the essay on that subject); for, when this friction, or dragging, is removed (by setting the friction bars at liberty,) the conical wheel is drawn nearly with the same facility as the cylindrical (see Exp. 4th and 7th); but when the dragging on the rim is again introduced, (by fixing the friction bars,) the resistance becomes as great as when the conical wheel rolls on the whole breadth of its rim, on one solid bar, (as in Experiment 1st).

EXPERIMENT EIGHTH.

34. The loaded carriage, with the *cylindrical wheels* placed upon the same frictoin bars, was drawn by 6 weights.

OBSERVATIONS.

35. *First*, But no motion of the friction bars took place, (although at liberty to move) because the motion of every part of the cylindrical rim was the same; each had an equal propensity to advance, and there was no dragging, rubbing, or counter-action on the rim.

36. *Second*, By comparing this experiment with No. 7, it appears, that when the friction arising from the different velocities of the parts of the *conical rim* was removed, the carriage with the conical wheels was drawn by the same number of weights as with the cylindrical wheel, (in Exp. 4th, 5th, and 6th): this also shews, that the resistance does not depend upon the breadth of the wheel, but upon the unequal velocity of its parts, arising from an improper shape; for where there is no difference of velocity (as with cylindrical wheels,) there is no motion of the friction bar, because the wheels roll upon them with more facility than the bars do on the friction rollers.

EXPERIMENT NINTH.

37. *The friction bars being fixed*, the carriage with the *conical wheels* was again drawn on the same bars, by 9 weights, *the same as in the first experiment, when the whole breadth of the wheel had an equal bearing on the road, and the rubbing on its rim took place.*

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38. This proves that the *difference* in the result of this experiment, and No. 8, arises *solely* from the rubbing at the rim of the conical wheels, all other circumstances being perfectly alike in both experiments.

EXPERIMENT TENTH.

39. *The friction bars remaining fixed*, the carriage with the *cylindrical wheels* was drawn, (as in Exp. 8th), by 6 weights.

OBSERVATIONS.

40. *First*, These two last experiments tend only to corroborate the 7th and 8th experiments, and prove, that the resistance on this path (composed of narrow bars, supported on friction rollers), is exactly the same, when he motion of the bars is stopped as on the solid bar, (in Exp. 1st and 4th); and by comparing Exp. 7th, 8th, and 10th, we see that the *cylindrical wheel* moves with as much facility when the friction bars are fixed, as when they are at liberty, because there is no rubbing or difference of velocity of its rim, to move the bars, as with the conical wheel.

41. *Second*, It appears, by comparing the 1st experiment with the 4th, and the 9th with the 10th, that under the similar circumstances of these experiments, the increase of resistance at the *conical rim*, occasioned by the rubbing which arises from the diff rent velocity of its parts, is equal to three degrees of acting power, or three-tenths of the whole resistance that the loaded carriage meets with on a *level path* (9), covered with a moderate quantity of dust or sludge; but this difference will not be so great with large, as with small wheels.

42. *Third*, In the first six experiments we see how much easier the same load is drawn upon cylindrical, than upon conical wheels; and consequently how much it is to the advantage of *the waggoner* to prefer the former to the latter; since, by that means, fewer cattle can draw the same load; or, if the same number be employed, the exertion required of them will be much less.

43. *Fourth*, The 7th, 8th, 9th and 10th experiments prove, that the increased resistance with the conical wheel, arises from the different velocities of the greater, and of the smaller parts of its rim: they exhibit to our view also, the destructive effects of the conical wheel, in grinding, breaking, and loosening the materials of the roads, as stated in paragraph 32, of the preceding essay: and this shews how much it is the interest of the *Trustees of Turnpike Roads* to discountenance the use of conical wheels.

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Explanation of TABLE *of* EXPERIMENTS.

44. In the following TABLE, the results of all the experiments are exhibited at one view, but in a different arrangment from that in which they are made: in order that those under similar circumstances with the conical, and with the cylindrical wheels, might be brought together, and more easily compared.

45. The first column in the table, (marked A) gives the number of each experiment according to the order in which they were made, that reference may, if necessary, be made to them.

Then follows a description of the circumstances under which each experiment was made.

46. In the column B, is given the number of weights required to draw the carriage, under such circumstances, so as just to *begin its motion* without assistance.

The column C shews, on the scale of acceleration, the number of spaces which the carriage advances, (5), after the weights have done acting upon it;—and estimating each division on this scale as equal in value to *one-tenth of the weights that draw the carriage* (5,) we ascertain how much the resistance to the progress of the carriage is less than the power by which it is drawn, *in decimals of that power*.

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A. Number of the experiments according to the order in which they were made.	TABLE OF EXPERIMENTS. The circumstances under which the Experiments were made, with the different sets of wheels.	B. Number of weights required to make the carriage begin its motion.	C. Number of spaces which the carriage advances after the weights have ceased acting.
1st.	The CONICAL WHEELS bearing on their whole breadth, were drawn by - - -	9	$0\frac{1}{2}$
4th.	The CYLINDRICAL WHEELS, ditto ditto	6	$3\frac{1}{2}$
2d.	The CONICAL WHEELS bearing on a fourth of their breadth on the middle tire - - -	6	1
5th.	The CYLINDRICAL WHEELS under the same circumstance - - - - -	6	2
3d.	The CONICAL WHEELS bearing on two slips on the extremities of their rims - -	11	0
6th.	The CYLINDRICAL WHEELS under the same circumstances - - - - -	6	$2\frac{1}{2}$
7th.	The CONICAL WHEELS drawn on friction bars, that remove the friction at the rim - -	6	$0\frac{1}{4}$
8th.	The CYLINDRICAL WHEELS on ditto at liberty, but the friction bars do not move - -	6	1
9th.	The CONICAL WHEELS on the friction bars (fixed) bearing on their whole breadth	9	$0\frac{1}{8}$
10th.	The CYLINDRICAL WHEELS ditto ditto -	6	$0\frac{3}{8}$

A RECAPITULATION *of the Effects with each Class of Wheels, from a Comparison of the similar Experiments made on each Class, as stated in the preceding Table.*

By the *first* and *fourth* experiments it appears, that the same load that is drawn on the *conical wheels*, by a power of nine, is drawn on *cylindrical wheels* by a power of six: and

That after the *power* has ceased acting, the carriage with the conical wheels advances only one *half a space*, on the scale of acceleration; but the carriage with the cylindrical wheels, although drawn by one third less power, has sufficient *motion* left to carry it forward *three spaces and a half*, after the descending weights have done acting upon it.

By the *second* and *fifth* experiments it appears, that when the conical wheel is made to bear on a fourth part only of its breadth at the middle of the rim, it is drawn by a power of six, and advances *one space* after the power has ceased acting;—but the *cylindric wheels*, bearing on the same portion of their breadth, and drawn by *the same power*, advance on the scale of acceleration, *two and a half divisions*, which proves, that even the *narrow cylindrical* wheel is drawn easier than the narrow conical wheel, and that the difference in favour of the narrow cylindrical wheel, is in this case, equal to $\frac{1}{18}$ of the power by which the carriage was drawn.

The *third* experiment shews, That when the *conical wheel* bears equally on the opposite extremities of the rim, *eleven weights* are required to draw it; and with this increased power, it stops the instant that the descending weights cease to act upon it; the uniform resistance to its progress being equal to the uniform action of the power, leaves no residue of motion to carry it forward.

The *sixth* experiment shews, that with the cylindrical wheels bearing in like manner on the extremities of their rims, *the same load* was drawn by *six* weights only; and the motion was so much accelerated as to carry the waggon forward two and a half spaces, after the weights had done acting on it.

And the result of all these experiments prove the following facts, viz.

THAT the greater resistance which takes place with the broader conical wheels, does not depend upon the breadth of the rim alone, but upon the breadth and the conical shape jointly.

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THAT, in conical wheels, the *increase of resistance* depends upon the difference of the velocity of the greatest, and of the smallest parts of its circumference, (Exp. 3.) and the exertion of the cattle will necessarily increase in the same proportion.

THAT, the resistance is increased on the same conical wheel, when the pressure of the load is confined to those parts of the rims that have the greatest difference of velocity. (Exp. 3.)

THAT, on the same principle, the resistance with the conical wheel *on a hard bottom*, is diminished by narrowing its bearing; but on yielding substances the effect is the direct contrary, (Exp. 2d, and 3d.)

THAT, since this friction and dragging of the conical rim is owing to the different velocities of the several parts of the circumference, it follows,

THAT every wheel which has not an equal velocity in every part of its circumference, must have a dragging and unnecessary resistance, that is, a resistance that may be avoided by giving to every part of the circumference, or rim, the same degree of velocity.

THAT, the only means by which an equal degree of velocity can be obtained in every part of the circumference of a wheel, is, by making all the parts exactly of the same diameter; and every wheel that has all its parts of the same diameter, must necessarily be *cylindrical*. And thus we see,

THAT the conclusion from the result of experiments, and from the theory stated in the preceding essay, concur in proving, that so far as regards the labour of cattle, or the facility of the progress of carriages, the cylindrical shape of a wheel is preferable to any other possible shape.

47. And this superiority of the cylindrical wheel, which has hitherto been illustrated by considering only the causes from which the greater resistance with conical broad wheels arises, * is further corroborated by the experiments that have been made with the cylindrical wheels, viz. the 4th, 5th, and 6th, in each of which, *the same number of weights* were required to make the loaded carriage begin its motion under the same variety of circumstances, which with the conical wheels occasioned the following difference in the number of the weights required to draw the same load, viz. 6, 9, 11, (see the Table, Exp. 2d, 1st, and 3d, column B.) and the number of weights that were capable of drawing the loaded carriage under each of those various circumstances on

*See Experiments 1st, 2d, and 3d.

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the cylindrical wheels, was only equal to the least that was required with the conical; and when the conical wheels bear on the extremities of their rims, 5 more weights are required with them than with the cylindrical wheels, (see Exp. 3d and 6th.)

48. And although no difference appears by the number of weights required to begin the motion of the carriage with the cylindrical wheels, whether they bear on the whole breadth of the rim; on a narrow part of its middle; or on the extremities of the felloes; it appears by the spaces which the carriage advances, on the scale of acceleration, (column C.) after the weights had done acting upon it, that

49. When the cylindrical wheel bears on its whole breadth, it advanced on the scale of acceleration, $3\frac{1}{2}$ spaces; * when bearing on one third of its breadth only, it advanced only $2\frac{1}{2}$ spaces; and when bearing on a fourth of its breadth only, advanced no more than 2 spaces: here then, we discover a most important difference between the cylindrical and the conical wheel; namely, that *the broader the bearing of the cylindrical wheel*, the more easily it advances, and the broader the bearing of the conical wheel, the greater is the resistance to its progress.

50. How much this *peculiar property* of the cylindrical wheel ought to recommend its use to THE FARMER, and the great advantages that may be derived from it, in preference to any other possible shape, for agricultural purposes, will best appear from the following concluding paragraph in the address of LORD SOMERVILLE to THE BOARD OF AGRICULTURE, on its meeting, the 27th of November, 1798.

51. "PREJUDICE apart, any system which embraces economy, and, that which is "of more importance, *dispatch in labour*, must be held up, under whatever form it "may present itself: *to enforce the good policy of* SEIZING THE MOMENT WHEN "GROUND IS IN TEMPER FOR WORKING, IS THE BASIS ON WHICH CROPS VERY "MUCH DEPEND. By the joint effects of precept and example, to stimulate men to "new efforts, by crying down with impartiality systems founded in error, and holding "up to public view such as merit imitation, *the Board of Agriculture* will fulfil the "purpose of its institution, and stand high in the estimation of every man who loves "his country."

52. If the carrying manure on cultivated, and on meadow lands, in all seasons, be an object within the scope of this excellent principle, how can it be better effected than

* And here it is to be recollected, that every space on this scale is equal in value to one tenth of the power by which the carriage is put in motion, (5).

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by using light carts, *on low cylindrical broad wheels?* and the wheels being of small diameter, will facilitate the loading; and they may be made of considerable breadth without any great addition to their weight; and as the resistance to the cylindrical wheel is not increased by increasing its breadth, and since the depth of the impression which it makes on soft earth is diminished by increasing the breadth of the wheel, much advantage much arise to the FARMER by using broad light cylindrical wheels for all the purposes of farming, as well as for those carriages that frequent the roads only.

53. Having now endeavoured to prove that the use of cylindrical wheels must be advantageous to the WAGGONER, not only by diminishing the labour of his cattle on *the same road*, but also by keeping that road in a constant state of better repair;—that it must be advantageous to THE TRUSTEES of the roads, by preserving and improving the roads, so as to be kept in better repair, at a less expence; that independent of the consideration of the public roads, it is equally the interest of THE FARMER to use broad cylindrical wheels, of a reduced size and weight;—if those facts which I have endeavoured to establish, with regard to the WAGGONER, the TRUSTEE, and the FARMER, be admitted, the universal use of carriage-wheels of a light construction, and with *broader* flat rims than are now used, will be universally adopted; which must very much improve the roads, diminish the expence of keeping them in repair, and increase the safety, pleasure, and expedition of travelling.

54. It cannot then be doubted, that every indulgence that can tend to encourage a more general use of heavy carriages, and cylindrical wheels, of a breadth proportioned to the number of horses (or other cattle) employed in drawing them, must be highly beneficial to the roads, and may ultimately be rendered advantageous to the public in a greater degree than has yet been mentioned; but, least I should exhaust the patience of *the Board of Agriculture*, I conclude for the present, with expressing my readiness to answer any objections that may be made *in writing, and signed with real name and address*; and to acknowledge any hints that may be communicated for further improvement or illustration; and if I have not been so fortunate as to offer such experiments, or to use such reasoning as to be universally understood, many other means may yet be suggested to illustrate a subject which appears to me to acquire additional importance with every step in the progress of its investigation:—but admitting that experiments could be devised, that must convince every person who *sees* them, unless that information be communicated to all those to whom it might be useful, and to whom, it might be equally advantageous to the public to have it communicated, the intended good purpose will be frustrated.

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55. Fully convinced as I am of the patriotic exertions of the Board of Agriculture, and highly sensible of its very flattering attention to my endeavours on this occasion, and of the powerful effect which its example and recommendation must have on the public mind, I am nevertheless of opinion, that the advantages that may be derived to the public from the management and improvement of the public roads, can never be obtained to the full extent, without a revisal of the turnpike laws, and new regulations regarding the formation of the roads, and construction of carriages, &c.

Pentonville, June, 1799. A. CUMMING.

The following Letter was thought the more worthy of insertion, from the attention which Mr. Upton paid to the Experiments, the shrewd observations he made, the reluctance with which he appeared to give up an opinion founded on long experience and attentive observation; and, lastly, from the candour with which he expressed his surprise at the result of the experiments, and acknowledged his entire conviction of the justness of the conclusions.

Mr. CUMMING,

SIR,

As under is the copy of a letter I mean to forward to Mr. JUDD of Banbury; if I have made any mistake respecting the *power* (if you please, horses), I will esteem it a favour that you will let me know.

Your humble servant,

June 1, 1779. THOMAS UPTON,

No. 27, Rodney-street, Pentonville,
Late of the Bell Inn, Warwick Lane.

Mr. JUDD,

SIR,

ON Thursday last I attended the Board of Agriculture, to see an experiment on waggons, drawn on the principle you and most carriers in the kingdom use—this experiment was made by a Mr. Cumming, the magistrate of our village, where we

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sometimes meet. We had previously been talking on the subject, but I never would have believed it, had I not seen it. Owing to the advertisement being worded in such technical terms, it never caught the eye of men interested in the business, and few persons in the business attended besides myself. When I was asked my address, I told them the truth, but added, in behalf of you. One of the members, (a Mr. Stratton, of Great Tew) who, I believe, knows you, was very polite to me;—he saw I was deaf, and brought me a chair into the middle of the room, and desired Mr. Cumming particularly to address me.

A waggon in minature like yours, 16 inches, (but flat on the sole) was set agoing, which required 9 horses to draw it;—the same waggon was set a going, with a *high tire* on the middle of the sole of the wheel, and which was drawn much quicker with 6 horses. Now all this was nothing new to me, or you: then a high tire was put on the inside and outside of the sole of the wheel, and taken off the middle of the wheel; it then required 11 horses to draw it; this, at first sight, I thought a useless experiment:—then a waggon was set off with the same load, on 16 inch wheels, quite cylindrical, like a garden roller; now this waggon only took 6 horses to draw it, which, I confess much surprised me: then a high tire was put on the middle of this wheel, and I expected of course it would have gone with less power, but it then required 6 horses to draw it, and with more difficulty. The Board saw I was struck with these two experiments, and begged I would communicate any ideas of doubt.—I begged these two last experiments might be performed again, which was done with politeness. After that, the high tire was put on the inside and outside rims of the cylindrical wheels, and taken off the middle, and 6 horses drawed it again;—this experiment did not then seem to me of much consequence, and some of the Board were going away, supposing all was over; but Mr. Cumming had a new turnpike road for these waggons to move on, which shewed and explained all the causes,—I wish you had been there to have seen it: I am doubtful of being able to explain it by pen and ink, but if I should not, it is not the first offence.—This road had two tracks, where the wheels of both waggons went on, that would give way, backwards or forwards, in a horizontal line, and when the waggon with the wheels of the conical form, or generally called *dished*, was used, that part of the road, where the largest part of the wheel passed, was thrown back, while that part where the outside passed on was thrown forward, evidently shewing, that those wheels are very injurious to the roads, as well as to the horses. The other waggon with cylindrical wheels, like a garden roller, made no

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difference at all; but if you will reason but five minutes, it is very plain; suppose a wheel of the size of the inside rim of your rollers, another wheel of the size of the outside rim, the smallest will go round much oftener than the largest betwixt London and Banbury; then, suppose them both put on one axle-tree, but so screwed together that both must turn together, must they not counteract each other against the power that moves them, as well as the ground it moves on? nothing so plain. And, farther, it proves that wheels truly cylindrical, go with less power that are widest on the sole.

Mr. Cumming hath promised me, if any number of carriers will attend, to shew these experiments.—I believe it is no uncommon thing for farmers, when the season has been very wet, and dung is wanted on the land, to send the broadest wheeled cart they have, for two causes, viz. the narrow wheels would sink in and cut up the ground, and of course would be harder to draw.

Your's sincerely,

THOMAS UPTON.

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XX.

Description of the Rt. Hon. Lord Somerville's *Drag Cart, &c. and Method of adjusting the Centre of Gravity of the Load.*

Plate XIX. Fig. 1. is a perspective view of a cart to be drawn by two strong oxen, by a pole, yoke, and bows, and to carry 45 cwt. In the front of this fig. is represented the method of adjusting the position of the centre of gravity of the load, to prevent its pressing too much on the cattle in going down hill, the front of the cart being elevated by means of a toothed rack screwed to the front of the cart, and worked by a pinion and the handle *a*, immediately connected with the pole *e*.—By means of this pinion and rack, the front of the carriage is elevated more or less, in proportion to the declivity of the hill, by which means the weight of the load is made to bear more on the axis, and less on the necks of the oxen.—On the side view of this cart is represented the manner of applying the friction-drag, which is made to press more or less on the side of the wheel, according to the steepness of the descent: *b b* is the friction bar, or drag; the one end of which is connected with the tail of the cart by a small chain, and the other end to the front, by means of a toothed rack, *b d*, which catches on a staple in the front of the cart, by which the friction bar may be made to press on the side of the wheel, more or less, at the discretion of the driver: the notches or teeth in this rack should be as close to each other as circumstances will permit.

The friction bar is here applied lower upon the wheel than was at first proposed, in order to divide the pressure and friction more equally on the opposite sides of the wheel, so that the pressure on each is diminished, the risk of over-heating and destroying the friction bars is also rendered less, than if the whole pressure was applied in one point on the top of the wheel.*

N. B. The weight of the iron work of this cart is 2 cwt. 20 lb.

* It has been somehow hinted, "That a drag somewhat similar to that which is here described had been used in the Durham coal pits;" but admitting this to be strictly true, it can in no degree

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Fig. 2.—A side view of a cart of smaller size, to carry 25 cwt. drawn by steers or small oxen, with the friction drag, *b b, out of use*; and representing another and more simple method of adjusting the centre of gravity of the load to the declivity of the descent: *a b*, is part of the arch of circle, whose radius is nearly equal to its distance from the axis of the cart, and having several holes in it, through which a strong iron pin is put to keep the body of the cart at any desired inclination with the pole.—*c.* a small chain to prevent the body of the cart being thrown too far back, through the carelessness of the driver in adjusting it.—*d d*, the upper stage of the cart, for carrying bulky loads. —The weight of iron to this cart, 1 cwt. 30 lb.

As the advantages of this *friction drag* have been stated in the Appendix to Mr. Cumming's Essay, it would be superfluous to repeat them here; the curious reader is therefore referred to page 381.

Plate XX. Fig. 1 and 2, are views of carts to be drawn by a single horse, by shafts: and by an attentive comparison of those drawn by shafts, with those that are drawn by the yoke and bows, the superiority of the pole to the shafts, and the advantage of making the cattle to draw by the yoke, in preference to drawing by the forehead, become evident.

When cattle draw by the shafts, (the one before the other) it is impossible for the driver to know that each exerts an equal force, so as to contribute equally to the draught; but when they draw by the pole and yoke, the point of draught being in the middle of the yoke, when the beasts draw equally, the yoke will stand square with the pole, and the position of the yoke will always enable the driver to discover the defaulter, and to bring him to a proper exertion: it is this harmony of draught, and equality of exertion, that gives so great an advantage to drawing by the yoke, that it is scarcely possible to say what weight of a load two good large oxen can draw on a level road. The powers of cattle drawing by the forehead, on Lord Shannon's

detract from the merits of him who has produced a contrivance that promises to be of much public utility, without the knowledge of what may, or may not, have been used in the Durham coal pits, or elsewhere; but what opinion must be formed of the *inattention* of that person, who knowing that so useful a contrivance was used in a coal-pit, never discovered the very useful purposes to which it was applicable in agriculture? Many are the useful contrivances that frequently present themselves to our notice, yet pass unobserved for ages; very few things occur that are absolutely new; the chief merit of invention and ingenuity consists in applying things that are known, in the most simple and judicious manner, to the most useful purposes to which they are the most applicable and best suited.

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Plate XIX

FIG.1.

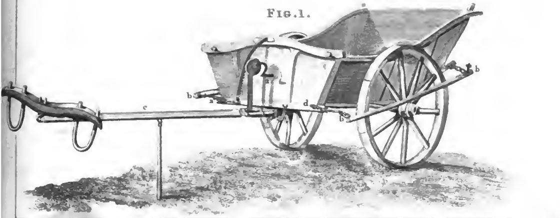

Fig.1 A Drag Cart intended to be drawn by a yoke of strong Oxen to carry 45 Cw.t

FIG.II.

Fig.2 A light cart to carry 25 Cw.t drawn by Steers or small Oxen

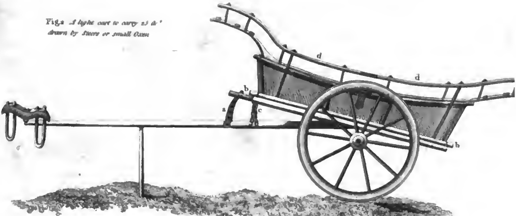

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Fig. I.

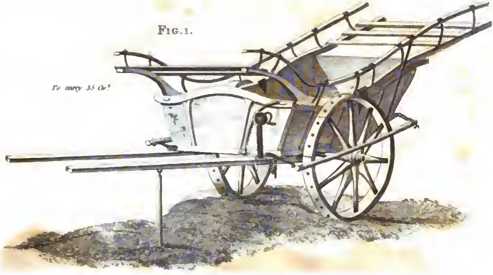

Fig. II.

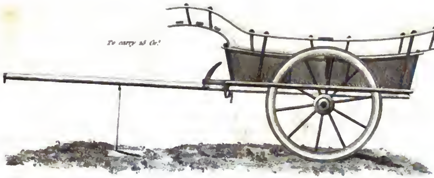

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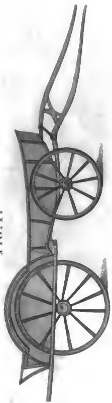
PLATE XXI.

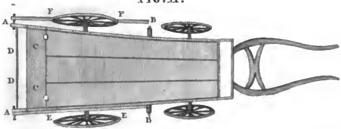
FIG. I.



A A. *The Point thro which the Drag is fastened by a bolt or loose Chain to the tail ladder*	D D. *Cross Bar of tail ladder for carriage of Casks, if necessary to roll them in at the tail of the Waggon this Bar may be made to shift and the tail board as usual to take out.*
B B. *Projecting block to which the Drag is set to impede the motion of the Wheel. — as Carts*	E E. *The Drag out of use resting on the projecting block.*
C C. *The tail board which rests upon & forms when required part of the tail ladder for carriage of Corn at Harvest time, of Hop Poles, of Hurdles &c. this tail ladder may be used w.th great profit.*	F F. *The Drag in use.*

The ladder should project from the tail of the Cart in order to give the best effect to the Drag 2.f 6 Inches. but this must depend on the nature of the Country, least in short turns it may run foul and disable the bolt.

FIG. II.



The advantage of this Drag, if any may be allowed, compared with the Drag Chain is as follows 1.st It admits by more or less pressure on the fellies an Impediment proportionate to the declivity which is not possible with the Drag Chain 2.d In farming uses of steep countries it does not cut up Land (a great objection to the Chain) nor does it destroy the foundation of Turnpike Roads, which must be the effect of the Drag Chain. — and here the Felly drag may become perhaps an object of Parliamentary notice. — moreover it does not strain the Wheels.

S.I.Neele sc. 352 Strand.

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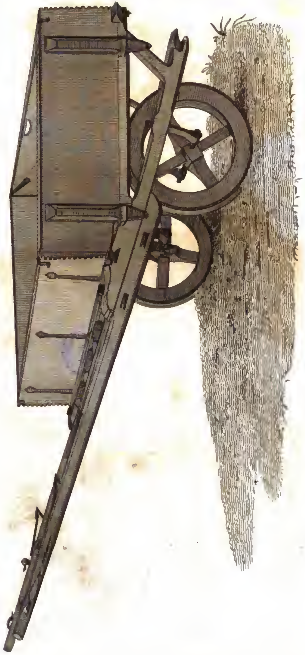
Plate XXII.

The Improved IRISH CAR as used and much recommended by the late Mr Bakewell of Dishley, Leicestershire.



Neele sculp. Strand

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Estate, are recorded by Mr. Young and Mr. Billingsley:—an ox of the late Mr. Tattersall, near Ely, drew four ton of wool on a level surface without apparent difficulty. What then might not be expected from the equal exertion of two such powerful animals, acting at the equal ends of the same yoke?

Plate XXI. Two views of a waggon with the friction drag, applied on the same principle as already described in the carts, &c.

Plate XXII. represents *the improved Irish car*, so much recommended by Mr BAKEWELL, the advantages of which appear to consist in the facility with which it is loaded, (from its lowness) and when gateways and roads are narrow, much room is gained by having the wheels under the body of the cart: *in such situations*, this cart seems well calculated for carrying manure, especially on meadow or ploughed land, and for that purpose its wheels ought to have a flat bearing, and to be *at least* six inches in breadth: another advantage of this car is, that from its construction, the wheels are *necessarily* cylindrical, at least they are necessarily not conical; and the facility of draught arising from this unobserved circumstance was probably imputed to some other part of the construction; and we see by experiments in the immediately preceding communication, that (contrary to the general opinion) *the resistance to the cylindrical wheel is not increased, but is diminished by increasing the breadth, and the flat bearing of its rim*: the knowledge of this fact is of very great importance to the farmer, as well as to the waggoner, since by this means he may be enabled in almost all seasons, to drive his broad-wheeled carts, &c. on his meadow or ploughed ground, when no narrow wheel can be used; the advantages of which are too well known to be here insisted on; but when the width of gateways and the breadth of roads will admit of the wheels being placed at the sides of the cart, *without confining the width of its body*, it will probably be more advantageous to have them at the sides, than under the cart.

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XXI.

The Rt. Hon. LORD SOMERVILLE's *Two Furrow Swing, and Wheel Ploughs, at nine Inches and a Quarter Furrow in the clear.*

SWING Ploughs, (Plate XXIII.) generally speaking, must be lightest of draught, because, with wheel ploughs, workmen are apt to set the points of their shares too low, so as by their inclined direction to occasion a heavy pressure on the wheel, which must proceed horizontally—the effect of this struggle is an increased weight of draught, infinitely beyond what would be supposed: for which reason the wheel is to be considered as of no importance *in setting a plough for work*, but passing lightly over the surface it will be of material aid in breaking old leys, or ground where flints, rocks, or roots of trees occur, and in correcting the depression of the shares from any sudden obstruction, as well as in bringing it quickly into work again when thrown out towards the surface. The clean and sharpened construction of the breast and throat will warrant their breaking deep stiff land with infinite success; in this case the coulters should be set nearly straight with the throat and shares: in cross ploughing or stirring, they may be set $\frac{3}{4}$ of an inch towards the land, thereby greater dispatch will be obtained in seed time. Should they carry too deep a furrow, the correction of their shares is obvious; should they hug too much to the land, or go unsteady to the ploughman, it must absolutely proceed from a want of setting them true, relatively to each other, and from an undue regulation of the cops; here a nice attention is required: their power also of cutting a furrow level at the bottom should after be proved on a level floor. The want of this practice in the master has condemned many a good plough, when the fault was in the ploughman only. It may suggest itself, that two furrow ploughs are unfit for hilly ground, but the very reverse is the case. The effect of ploughing across the inclined plane, or hill, is that of carrying the soil in time to the bottom of the field, which must be carted bodily up again at a great expence: let such land be

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worked from the top to the bottom; let one furrow be carried with the hindmost or land share up the hill, and two down, so will the power be apportionate to the weight with which it has to contend, and needless toil to the team will be saved. That power which was required to carry two furrows up would be superfluous in carrying the same down the hill, and the effect will be as 3 to 4, that is, an acre and a half, instead of two acres per day.

An economical and spirited system of farming labour already prevails in some districts; in none more eminently, with respect to ploughing, than in Essex, on both banks of the Tweed, in Suffolk, Yorkshire, and Norfolk. Here it would be no object to invade the system already established, for innovation is not palatable to farmers; nor should the first deep ploughing in *Kent* give way to any novel system; there can be no better husbandry; but, except for beans and tap-rooted plants, subsequent deep ploughings are injurious, both as to expence and effect. Dr. Hunter, in his Essay on *the Roots of wheat*, points out the depth needful for the supply of *seminal roots* in wheat and wheat corn in general; that which is turned down then, in the first deep ploughing, should be rotting for the succeeding crop. Let not the bottom know what the surface is doing! Here, TWO FURROW PLOUGHS, even admitting them incapable of carrying a deep furrow, which is far from true, must come into admirable effect, for a twofold advantage can be taken, of the season in sowing, and the work being done at half the expence. But where men are chained down by long usage, and perhaps for the convenience of constant road work, to teams of heavy corn-eating cart horses, two furrow ploughs become objects of extreme importance, because their horses will not feel the difference between their own single furrow, working one acre, or the well constructed two furrow plough, with two acres per day: here is no system deranged, and double work done.

The counties of Leicester and Stafford have profited much by their use under these circumstances, although their two furrow ploughs, in other respects good, have never been so constructed in the throat and breast as to destroy the means of resistance. Without doubt, obtusity in these particulars must add incalculably to the weight, must break the furrow, and so spoil the work; moreover let it not be forgot, that removing resistance not only diminishes the labour of the cattle, but is also of equal advantage in increasing the strength of the implement;—the resistances with a well constructed, and with an ill constructed, plough, in performing the same work, are as different as the

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resistance of a well constructed king's cutter, and of a floundering Dutch merchantman, sailing with equal velocity.

As the general introduction of these ploughs, and their ultimate success, must, in a great degree, depend on the attention and willingness of ploughmen, it is requested that some small gratuity be bestowed if they succeed, or that they be dismissed if found negligent in bringing into effect an implement, which, in any country, must be a saving of some, and in most parts of infinite labour and expence: ten shillings saved are ten shillings got.

It is but gratitude on the part of him who invented them, to say, that in his own country these ploughs have met with a reception more favourable than could be expected in so short a period. On the 16th of October 1798, two furrow ploughs were not thought capable of breaking up ley ground, although in constant use for fallowing, but from their construction requiring six oxen. On the 16th of October, 1799, a very large and respectable Farming Society gave a premium for two furrow ploughs, working ley ground only. On the day following, in the presence of many members of this Society, one acre and a half of ley ground was broke up by four oxen, with infinite ease to themselves, in 3 hours 55 minutes, they having, as part of a constant course of work, ploughed 17 perches short of an acre of ley ground the same morning: this was done *to prove the effect of moveable plates at the extremities of the mould-board*, that the furrows might be laid more or less flat; for mould-boards, formed to lay furrows in ley, so as to give the most soil to harrows, cannot be of that form best calculated to make good work in stirring earths, more especially the last, which ought to be thrown up in small seams as it were, that the seed may be duly buried. It has hitherto been held necessary to rip off the plate for this purpose, and drive in wedges, by which the mould plate must be injured. From the trouble attending this operation it has for ever been omitted, and the land of course imperfectly worked. But this inconvenience may be remedied, and the mould-board be adjusted with great facility and expedition, by the following means:—When the mould board is formed, and its plate fitted as usual, let the parts marked (a a), Plate XXIII. be cut off, and again connected with the fixed part of the mould-board by means of flat hinges, or of thin flexible plates of tempered steel, or of hard hammered iron, so as to admit of those parts being set to have different inclinations with the fixed part of the mould-board: by means of two screws passing from the inside through the lower parts of the

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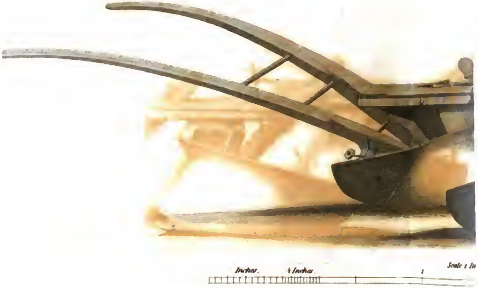

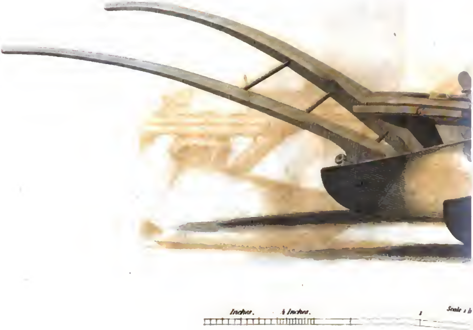

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Pl

Scale 1 Inch to a Foot.

1 2 3 4 5 6

Scale 1 Inch to a Foot.

1 2 3 4 5 6

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handle of the plough, opposite the backs of these moveable pieces (a a); those screws may be made to keep them at any desired degree of inclination, according to the nature of the work to be performed.

Ley ground cannot be laid too flat, or seed earths too much on an edge; and by this improvement of the mould-board, the plough may be instantly adjusted for either purpose: when these moveable parts are screwed outwards it will cause a proportionate convexity in the base of the furrow, and so give more earth to cover the seed. That plough which can give most mould to the harrow, is the best for a ley crop.—That part of the mould plate that is marked with the dotted line (c c), being found most liable to wear, should be made of a double thickness, i. e. twice the thickness of a new crown piece; it will then last nearly as long as the plough.*

It cannot be deemed irrelevant to the subject, here to state the result of a challenge given to the owner of these ploughs, to plough 24 days' work successively, on his Majesty's farm, either at Kew or Windsor, on the 10th of March last. The challenge was accepted, and it is a matter of regret that this challenger did not venture to appear, although repeatedly urged to do so; because, a trial for such a length of time, and between two breeds of cattle so distinguished for their powers in labour, must have thrown great light on a subject of such importance to the farming world. That something, however little, might be proved, his Majesty was pleased to allot the only piece of land then unstirred, $17\frac{1}{2}$ acres, statute measure, which was ploughed by a two furrow plough, 4 Devonshire oxen, 6 years old, a man, and boy as driver, in six days and a few hours: the oxen were in good order at the commencement of their work, and finished it higher in order, as well as in flesh, than when they began. This is a strong fact; but numbers in the vicinity of London know it, and are ready to prove the fact. These oxen, as is the custom in their country, never tasted corn.

The following letters are the last received on the subject of these ploughs; they have failed in one instance only, which, on examination, was instantly set right.

* The increased weight of draught when these moveable plates were extended, did not appear, in a two furrow plough to be by the caps more than 12 pounds in ley ground at 6 inches depth. It is needless to state the success of these alterations; the friction in furrows required to be laid flat, was less than could be supposed, probably not more in both furrows than from 12 to 6 pounds.

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Evesham, Sept, 24, 1799.

Mr. Perrott desires to return thanks for your kindness in sending the plough I wrote for; he says it does the work well, and is on the best construction he ever saw.

BENJ. JOHNSON.

Buckland Abbey, Devon, Sept. 25, 1799.

I beg leave to say, the two ploughs you were so good as to send here, are the best I ever saw, in particular the wheel plough.

G. SCORE.

Radhall, near Ross, Herefordshire.

I have now the satisfaction to tell you that though the plough did not arrive till after I had been obliged to send away your servant, we have found no difficulty in working it, and is well liked in general by those who have seen it work: I have little doubt it will be adopted by many of my neighbours: it certainly makes exceeding good work, and turns the furrows remarkably well. The time of its arrival was not the most favourable, as our soil, in general light and easy, is now, by the wet and sun, caked, and works with great difficulty; notwithstanding which, not one farmer but says it will be of great use in many instances. It is lucky for me my ploughman likes it, double, and is inclined to use it on all occasions.

THOMAS WESTPHALING.

London, August 14.

Yesterday I saw Mr. Shirley from Warwickshire, who gives a good account of your double plough; he sees no difference between the draught of four horses in the double and his own single furrow plough.*

JAMES M'DOUGALL.

*** By application to the Board of Agriculture these ploughs may be obtained; and when set true in every part, they will carry a furrow of great depth with little assistance from the ploughman.

* The same observation has been made by the ploughmen of J. Fisher, Esq. and the Rev. George Trevelyan near Taunton, as well as confirmed by the decided testimony of their masters.

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The Prices are as follow:

Country prices.—Swing Plough, with wooden mould-board,	£.	4	10
Wheel ditto, ditto, — — —		5	16
London ditto.—Swing Plough, with iron board-sides, — —		6	6
Wheel ditto, ditto, — — —		8	8

The above prices for immediate payment: if on credit, 10 per cent. more.

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XXII.

Account of Mr. Ducket's *Hand-Hoe.*

Hand-hoeing is an operation of so much consequence to drilled crops, and is, in some situations, so expensive, that Mr. Mark Ducket, jun. invented one for doing more work, and at a less expence than the common ones.

The annexed Plate represents it in all its variations.

A. is a treble hoe for hoeing three rows at a time; the person that holds it *advancing* in the usual manner. It weighs $7\frac{1}{2}$ pounds,* being heavy enough to give ease to its entrance into the earth of light soils, and not beyond the power of a woman to use that has been accustomed to field work.

With these hoes a fine tilth is struck into drills for receiving any sort of seeds, with far more expedition than the common method of striking with the corner of a common hoe, along a packthread; for by opening one drill correctly by the eye, looking at stakes set up for a mark, all the rest are made with great truth.

B. is also a treble hoe, but the shares set for drawing, the person holding it going backwards, and in order to give a due pressure, without fatiguing the wrist in bearing on it, the inventor has ingeniously added the power of a rope, which going round the person's body, draws also from that spot in the handle where the pressure would be given with the hand.

C. represents the hoes as used for making trenches in gardens for receiving the manure for planting potatoes; these trenches, of any proper breadth and depth, are made very expeditiously by striking in a line, drawing up the moulds in a half ridge, and then

* The weight of Mr. Ducket's hand-hoe, with the three hart hoes - -	7 lb.	9 oz.
Weight of ditto, with the two 12 inch hoes, is, - -	7	3
Weight of ditto, with the three straight 6 inch hoes - - -	6	11
Weight of the handle without any hoes - -	4	3

The price of the hand-hoe complete £. 1 10.

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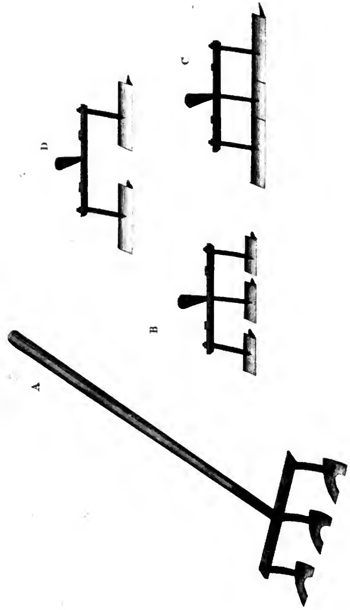
Plate XXIV



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turning and going back finishes the ridge, so effective that a woman has, in a very fine tilth, trenched shallow for early potatoes an acre in a day.

D. shews the two outward hoes, with a space left in the middle to hoe on each side a drill of any plant with safety and expedition.

Mr. Ducket worked all these tools before me; I also wrought with them myself, and found them very handy, and such as I conceive can want only to be known in order generally to be adopted in gardens, nurseries, and light soils.

William Napton, servant to Lord Somerville, was at Mr. Ducket's the middle of June 1799, by his Lordship's order, to make himself a master of using Mr. Ducket's newly invented hand-hoes. He hoed a land of barely, containing the 5th part of an acre, drilled at 9 inches, in 36 minutes, but could not work in that proportion; he is clearly convinced that he could hold it, at the rate of two acres a day for any time: used the treble horse-shoe hoes: he found no difficulty in the use of this tool, going backwards, but it takes double the time to go forwards, which it does to do the work backwards. He made, in Mr. Ducket's opinion, very good work with it, in barley, oats, and wheat. He also trenched some land up in ridges with the two long and one short hoe fixed, and found the tool so effective and handy for this work, that he thinks he could do twice as much work with it in trenching, as a spade could do in the same time. Likewise he made trenches for potatoe planting, for which purpose, as well as any others in light land, he found it a most handy and useful implement. He tried it upon every sort of soil on Mr. Ducket's farm, and the land he did in 36 minutes was the worst for hoeing he saw on the farm. He found the application of a strap around the waist, to press as above described, to be highly necessary, as it eases the labour very materially.

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XXIII.

Letter from John Talbot Dillon, *Esq. M. R. I. A. Under Secretary to the Board, to the Right Hon.* Lord Somerville, *President of the Board of Agriculture, respecting the Fleeces of the Spanish Merino Sheep.*

My Lord,

As your Lordship has done me the honour, with some other noble Lords, and Gentlemen, to glance an eye over my *Travels through Spain, in order to ascertain the Natural History and Physical Geography of that Kingdom,* which after my return from Madrid, in 1778, I published in London in 1780, I beg leave to mention, that there is in that volume an error of press, and an omission of some consequence, with respect to the weight of the fleece of the famous *Merino* sheep, and I now take the liberty to specify the same, with your Lordship's kind permission and indulgence, and shall be happy if my correction may have the good fortune to find its way through the annual communications of the Board, to such persons in general who may be possessed of the book of Travels above-mentioned.

The case stands thus:

Page 50. *For the fleeces of these rams will weigh 25 lb.*

It should be, *For the fleeces of three of these rams will weigh an arroba, or about 25 lb.; moreover, there must be four wethers, or five ewes, to equal that weight.*

All the Spanish writers, my Lord, since the beginning of this century, seem to agree that the number of the fine *Merino* sheep, amounts at present to between 5 and 6 millions, notwithstanding they had previously dwindled under Philip III. and IV. and the distracted reign of Charles II. their last Austrian monarch, and the well known succession war that ensued at his demise, which terminated by placing Philip of Bourbon on the Spanish throne.

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With respect to the wools of Spain in former days, and our clothing trade, and relative connection with that kingdom in the 14th century, I gave a statement thereof a few years ago, in my *History of the Life of Peter, surnamed the Cruel, King of Castile.*

With every apology for this interruption, permit me, my Lord, to have the honour of subscribing myself with the most profound respect,

My Lord,

Your Lordship's

Most obedient,

And obedient humble servant,

JOHN TALBOT DILLON.

Board of Agriculture,
Sackville-street,
June 22, 1799.

Rt. Hon. LORD SOMERVILLE,
President of the Board of Agriculture,
&c. &c. &c.

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XXIV.

Letter from Sir JOHN CALL, *Bart. M. P. to the President of the Board of Agriculture, on the Smut in Wheat, Blights, and the Manner in which Plants are nourished.*

MY LORD, Old Burlington-street, April 29, 1799.

HAVING often reflected upon the nature of smut in wheat, and considered the various propositions and suggestions which had been made from time to time, for cleansing the grain, so as to prevent its affecting the flour; as also to prevent the smut from being propagated in the seed wheat so affected, I was led to deliberate in my own mind whether the smut was a disorder, or disease, inherent in the seed, or an adventitious effect from the atmosphere; or some animalcula deposited in the ears of corn, during their growth. In reasoning on this subject, it occurred to me, that if the disorder, or disease, called the smut, was inherent in, or latent in the seed grain, and that all such grain, when sown, would produce only ears full of smut: then, unless the disorder could be cured by some previous application, there would be a risk of having all the crops rendered abortive, where a remedy was not applied; or if, as some persons had supposed, that the nature of the soil had contributed to produce the smut in wheat, then such soil, unless it could be corrected, would become unfit for, or dangerous to tillage. To satisfy myself at least how far the smut was a disorder liable to be propagated by seed grain taken out of smutty ears, or other grain mixed up with, and rubbed in smut, I resolved to make the following experiment:

In the year 1797, when my men were thrashing out my wheat, I desired them, as well as some of my neighbours, to save all the ears they met with which were affected with the smut: having collected all I could get, previous to the beginning of October, I found some ears wholly decayed, some with one, two, or more grains, apparently perfect, all which I caused to be rubbed out with the hand in a bag of paper, smut and all together; and after mixing and rubbing the grain in the smut, all I could get

perfect out of smutty ears amounted to 72 grains, which were carefully dibbled in, and marked in a ridge amongst other wheat, in a field then under tillage. Their growth from the first was similar to the rest of the field. The certificate which I deliver herewith, and the specimens of about 60 ears, gathered from the produce of the 72 grains, among which are contained every ear that appeared discoloured, or was thought by the examiners to be tending to smut, will serve to corroborate my opinion; which, as I observed before, is, that certain animalcula are deposited in the husks which cover each grain, about the time the wheat is in blossom, which are fed and brought to perfection by devouring the juice, or milky substance which rises at the root,* and that if not intercepted, would form a complete grain. Instead of which, as in many other cases of vegetation, the vegetable life, as I may so call it, is destroyed; and as a farther proof, that this is the case, and that the effect is not by the juices issuing from the earth, or rising through the tubes of the stalk, I need notice no other effect, than, that some grains perish and become smutty, while others flourish and become perfect in the same ear of corn; whereas, was the disease, which is supposed to occasion the smut, radical in the original grain of seed wheat, or infectious from the juice arising through the pores and tube of the stalk, all the grains in each ear would be affected, or those more particularly at the lower part; whereas the grains decayed are often found intermixed with others quite perfect, and dispersed throughout the ear. I therefore trust that the prejudice conceived, that the smut in wheat is an inherent disorder, will be relinquished; or that another idea, that one kind of ground is more likely to produce smut than another, will be abandoned. I do not deny that a considerable degree of smutty wheat thrashed out, and the smut of it mixed with other pure grain, will injure and prejudice the white casting of the flour, and that it may be necessary to wash and cleanse such wheat, previous to its being ground, where the smut evidently prevails; but I think my opinion of the origin of such smut is much strengthened by its prevailing more in one year than in another, and that it seldom happens the same complaint is made by farmers in two succeeding years, notwithstanding there is no precaution taken, or remedy applied to the seed grain to prevent it; and with regard to my own experience during 29 years, I have neither mixed up my seed wheat with lime, nor steeped it in brine, nor washed it in any other liquid to prevent the growth of smut: nor do I believe any of my neighbours have made use of any such precautions.

* The root here meant, is the root of each grain in the husk.

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Analogous to this idea which I have endeavoured to explain, I am tempted from one observation to hazard another respecting the blossoms, and setting of young fruit, on fruit trees, but more particularly that of apple trees, in which a failure of fruit happens one, two, or three years together, and which is so detrimental to the produce of the orchards in Devon and Cornwall, that in the parish of Stoke Climsland, where I reside, there have not been made, during the last three years, 500 hogsheads of cider, whereas in a good bearing year there are usually made from 1500 to 2000 hogsheads. This defect is generally ascribed to frosty mornings, cold winds, and blights, particularly to the latter; and I am apt to believe that it is in, and from the latter, where the mischief arises, not from any simple effect of the atmosphere, but from the animalcula with which it is replete in such fogs, and which are deposited in the blossom, as in a nidus, and there brought to perfection by feeding on, and destroying the vegetable life by which they were originally nourished. Hence it is, that bunches of young fruit, set, and grown as big as hazle nuts, fall off from the branches of the tree at the stem, which seem to be eaten off and deprived of the reception or conveyance of all nourishment, and often crumpled up by a kind of web and dry leaves. To prevent the supposed effect of blight, cold wind, and hoar frost, on wall-fruit, a net is often hung up before them, stuck full of dry fern, or other branches, to shelter the trees, without obstructing the air; and others stick in among the fruit trees, branches of firs to cover and protect the blossoms, both which modes probably have some good effect by intercepting and preventing the animalcula from taking post in the blossoms, or attaching themselves to the root of the young fruit.—It is now three years that I have repeated the experiment of dibbling in and sowing some of the best seed wheat, and some of the most shrivelled grains, or tail part of the same wheat, after winnowing: and from the result of the experiments, I am satisfied that a gallon of shrivelled grains of wheat, retaining the power of vegetation, will produce a return of as good wheat in quality, and probably more in quantity, than a gallon of the finest grain of the same sort that can be separated by winnowing, or any other selection. The only advantage that I am disposed to grant, to fair, clean, and well screened seed wheat, is, that it will be more free from cockle, or any other extraneous seed, than the tail winnowings or shrivelled seed is likely to be;—but on the other hand, a gallon of the shrivelled seed will contain three grains to two of the other, and probably will not be so much an object to be devoured by insects, birds, and vermin, as the more plump and full grains are; hence if my hypothesis is well

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founded, the advantage in favour of produce at the harvest will be in the shirivelled grains. A certificate to this effect will be found in the annexed paper-

The conclusion which I am disposed to draw from these experiments goes much beyond the advantage of converting the best kind of wheat, or other grain, to flour, and making use of an inferior sort for seed. I have been led to consider and revolve in my mind how far, and in what manner, any kind of manure contributes to the production of the crop: that it does so in the most essential manner, I do not entertain a doubt; but I differ from those who think that any kind of manure mixed with the earth, rises up through the roots, and forms any considerable part of the plant, fruit, or grain whatsoever: it may contribute to break the tenacity of the soil, to render it warm, open, and easy of perforation, so that the tender fibres, and roots of any plant may find an easy passage and genial protection therein; but I conceive that all the nourishment and juices necessary for the growth of the plants, and formation of their fruits and seeds, is derived from the atmosphere; that it enters and descends by the buds and heart of all vegetables, and that the earth is only a protecting matrix to retain and support all vegetable matter in a position to receive its nourishment. It is in forming, collecting, or attracting this nourishment, that manures are of such importance to all kinds of vegetation, either by attracting and fixing the circulating atmosphere, to hover over the earth where they are, so that the plants may imbibe what is proper for them; or by causing such a fermentation, or secretion in the earth, that by the attraction of heat it should throw up such a species of food and nourishment as is most congenial to that kind of vegetation for which the earth is cultivated.

I will not pretend to enter into a nice discussion of the cause and powerful effects of vegetation, or attempt to controvert any opinions which have been long held on the subject; all I desire is, that the ideas I have thrown out may be favourably considered, or the experiments fairly repeated, and that I may be allowed to think that a large turnip, weighing 5 or 6 pounds, with a very strong and large top, held only to the earth by a small tap root, and a few little fibres; or that a cabbage weighing 20 or 30 pounds, standing high on a small stalk, were not wholly formed and grew to that size by moisture or substance rising through their roots out of the earth.

I am, my Lord,

Your Lordship's

Most obedient servant,

JOHN CALL.

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We whose names are hereunto subscribed, having been requested by Sir John Call, Bart. of Whiteford in the parish of Stoke Climsland, in the county of Cornwall, to view and examine a field of wheat just then fit for reaping, and to take particular notice if we saw any difference in appearance of some part, from others, do declare, that in a ridge marked No. 2. (where 72 grains of smutty wheat, after being rubbed out in a bag, and mixed up with the smut, and in that state hath been dibbled in), we only found 2 ears, out of about 300, which grew out of the stocks from the smutty seed, that had apparently smutty grains in them, and we found many similar ears in other ridges of the field, so that it did not appear that the smut had been particular in that part.

That having examined a ridge, No. 5, sown with shrivelled wheat, the crop appeared as productive as any part of the field that was sown with the best seed wheat.

August 2, 1798.

Coss. Radcliffe, Rector.
John Budge, Farmer.
John Nottle, Farmer.

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XXV.

LEDGER ACCOUNT *of* THE FARM *of* MR. WILLIAM DANN, *of* GILLINGHAM, KENT, *for* 1797, *with* REMARKS.

This very ingenious and accurate FARMER *having mentioned to some Members of the Board of Agriculture his Method of keeping a* Field Account *of his Farm, which appeared interesting, he was requested to attend the Board; which he not only complied with, but permitted the following Extract, for One Year, to be made from his Ledger. It is here inserted as a Specimen of a Method of keeping Accounts.*

N. B. I suppose the straw and chaff to be equal to the expence of harvesting thrashing, carrying to and from barn, and attending markets.

I suppose the afterpasture, called Rouens, sufficient to pay for mowing, making and carrying sainfoin, &c. and therefore shall make no charge for them.

1797.

No. I. 22 Acres.

		£.	s.	d.		£.	s.	d.
	Rent, 20*s.* taxes and fences, 4*s.* 6*d.* - - -	26	19	0	Aug. 29. By 55 qrs. 3 bush. of wheat, at 55*s.* - -	152	5	6
Oct.	Ploughing 17 acres, at 11*s.*	9	7	0				
	Broadsharing 5, at 5*s.* -	1	5	0				
24.	6 qrs. 5½ bush. wheat, 60*s.*	20	1	3				
	Putting in and harrowing, at 3*s.* per acre - -	3	6	0				
Mar. 7.	6 bush. 7 gal. clover seed, at 24*s.* - -	8	5	0				
	Putting in with machine, sowing, harrowing, and rolling	3	6	0				
June.	Weeding - -	1	13	0				
		74	2	3				
	Gain - - -	78	3	3				
		152	5	6		152	5	6

No. II. 18 *Acres* 2 *Roods.*

	£.	s.	d.		£.	s.	d.
Rent, 20*s.* taxes and fences, 4*s.*6*d.*	22	13	3	By 131 qrs. 4 bush. oats, at 21*s.* -	138	1	6
Nov. Ploughing, at 12*s.* - -	11	2	0				
Mar. Putting in oats, harrowing, and rolling - -	4	3	3				
12 qrs. 3 bush. oats, at 21*s.* -	13	0	0				
Scarifying and weeding -	2	15	6				
	53	14	0				
Gain - -	84	7	6				
	138	1	6		138	1	6

No. III. 4 *Acres* 3 *Roods.*

	£.	s.	d.		£.	s.	d.
Rent, taxes, and fences, 24*s.* 6*d.* -	15	15	0	Rent - - - -	15	15	0

No. IV. 1 *Acre* 3 *Roods.*

	£.	s	d.		£.	s.	d.
Rent, taxes, and fences, 40*s.* -	3	10	0	By fruit - - -	6	0	0
Tithe and weeding - - -	0	17	0	Pasture - - -	3	10	0
	4	7	0				
Gain - -	5	3	0				
	9	10	0		9	10	0

No. V. 5 *Acres* 3 *Roods.*

	£.	s.	d.		£.	s.	d.
Rent, 20*s.* taxes and fences, 4*s.* 6*d.*	7	1	0	By pasture - - -	15	5	0
Tithe and weeding - - -	1	0	0				
	8	1	0				
Gain - - -	7	4	0				
	15	5	0		15	5	0

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No. VI. 11 *Acres.*

	£.	s.	d.		£.	s.	d.
Rent, 20s. taxes and fences, 4s. 6d.	13	9	6	By 14 loads of fodder on a part -	29	8	0
Rolling clover, weeding, and tithe	3	11	6	By 2½ acres, mown twice for horses	15	0	0
Half the expence of thrashing clover seed, and the whole of mowing -	2	18	0	By 4½ bush. clover seed, 21s. -	4	14	6
	19	19	0				
Gain - -	29	3	6				
	49	2	6		49	2	6
Clover seed, and putting in last year, £.11 18s. 3d.							

No. VII. 11 *Acres* 2 *Roods.*

	£.	s.	d.		£.	s.	d.
Rent, 16s. taxes and fences, 4s. -	11	10	0	By pasture, at 50s. - -	28	15	0
Weeding and tithe - - -	2	0	0				
	13	10	0				
Gain - -	15	5	0				
	28	15	0		28	15	0
Clover seed, and putting in last year, £.14 2s.							

No. VIII. 4 *Acres* 1 *Rood.*

	£.	s.	d.		£.	s.	d.
Rent, 20s. taxes and fences, 5s. -	5	6	3	By 4 qrs. 3 bush. wheat, 55s. -	6	10	6
Nov. Ploughing 1½ clover-lay, at 14s	1	1	0	By 1050 bush. potatoes, at 1s. -	52	10	0
Putting in and harrowing -	0	12	9				
3½ bush. wheat 7s. 6d. -	1	6	3				
Feb. Ploughing lucerne, at 16s. -	2	8	0				
Mar. Planted 35 sacks potatoes, holes made with iron pitch on the sod every other furrow -	4	19	0	350 bush. per acre, prime cost 6d. per bush.			
Planting, 10s. an acre, and harrowing - -	1	16	0				
June. Hoeing and weeding, 5s. 6d.	0	17	6				
Horse-hoeing and earthing twice, 2s. - -	0	12	0				
Rolling and weeding wheat -	0	6	0				
Oct. Digging 350 sacks potatoes, at 5d.	7	5	10				
Loading carts, carrying -	0	9	5				
Sacks, and bailiffs' attendance	1	10	0				
Tithe potatoes - -	1	10	0				
	30	0	0				
Gain - -	29	0	6				
	59	0	6		59	0	6

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No. IX. 19 *Acres* 1 *Rood.*

		£.	s.	d.		£.	s.	d.
	Rent, 16*s.* taxes and fences, 4*s.*	19	10	0	By 19 qrs. 1 bush. wheat, 55*s.*	52	11	6
Sept.	Putting in wheat on pea-stubble, without ploughing, 9 acres	2	9	6	By 3333 bush. potatoes, at 1*s.*	166	13	0
	20 bush. wheat, 7*s.* 6*d.*	7	10	0				
	Folding 1 acre	1	0	0				
Mar.	Hand-hoeing	1	16	0	333 bush. per acre, prime cost 7¼ per bush.			
	27 bush. sainfoin-seed, 4*s.* 6*d.*	6	9	0				
	Putting in with machine, harrowing, and rolling	0	18	0				
	10 acres potatoes, 174 loads dung, 2*s.* 5*d.*	21	15	0				
	95 sacks, 3*s.* 6*d.* and cutting	16	12	6				
	Ploughing, planting, harrowing, and rolling	8	19	6				
June.	Hand-hoeing and weeding, 7*s*	3	10	0				
	Horse-hoeing thrice, 6*s.*	3	0	0				
Oct.	Digging 1111 sacks, at 5*d.*	23	2	11				
	Loading, carrying	3	1	7				
	Sacks and bailiff	5	0	0				
	Tithe potatoes	5	0	0				
		129	14	0				
	Gain	89	10	6				
		219	4	6		219	4	6

No. X. 13 *Acres.*

		£.	s.	d.		£.	s.	d.
	Rent, 16*s.* taxes and fences, 4*s*	13	0	0	Oct. By 4227 bush. at 1*s.*	211	7	0
Apr.	Potatoes, 252 loads good dung, at 3*s.*	37	16	0				
	151 sacks seed, and cutting, 3*s.* 6*d.*	26	8	6	Per acre 325. Prime cost near 8*d.*			
	Dunging and tillage, &c.	11	18	6				
	Hoeing and weeding, 6*s.* 6*d.*	4	4	6				
June.	Horse-hoeing thrice, 2*s.*	3	18	0				
Oct.	Digging 1409 sacks, 4*d.* and 5*d.*	24	16	10				
	Loading and carrying	1	19	8				
	Sacks, and bailiff's attendance	6	10	0				
	Tithe	6	10	0				
		137	2	0				
	Gain	74	5	0				
		211	7	0		211	7	0

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No. XI. 6 *Acres*, 1 *Rood*, 30 *Perches.*

	£. s. d.		£. s. d.
Rent, 16*s.* taxes and fences, 4*s.*	6 10 0	By 8 loads fodder, at 42*s.*	16 16 0
Tithe, rolling and weeding sainfoin	1 15 6		
	8 5 6		
Gain	8 10 6		
	16 16 0		16 16 0
Seed the year before, &c. £.7 15*s.*			

No. XII. $8\frac{1}{2}$ *Acres.*

	£. s. d.		£. s. d.
Rent, 14*s.* taxes and fences, 3*s.* 6*d.*	7 8 9	By 15 qrs. 3 bush. pease, 32*s.*	24 12 0
		Loss	13 11 6
Jan. Ploughing, 14*s.* harrowing, 2*s.* 6*d* and putting in pease with drills, 1*s.*	7 8 9		
41 bush. grey pease, 4*s.*	8 4 0		
Rolling	0 5 0		
Hand-hoeing once, horse-hoeing twice	3 4 0		
Sept. Ploughing, harrowing, and sowing tares	7 13 0		
16 bush. tares, 5*s.*	4 0 0		
	38 3 6		38 3 6

No. XIII. 9 *Acres.*

	£. s. d.		£. s. d.
Rent, 14*s.* taxes and fences, 3*s.* 6*d.*	7 17 6	By 19 qrs. 6 bush. beans, 22*s.*	21 15 0
		Feed on turnips	10 12 0
Jan. Ploughing	5 8 0		
Feb. 5 qrs. Mazagan beans, 24*s.*	6 0 0		22 7 0
Tillage, putting in	2 14 0	Loss	4 10 6
Hand-hoeing once, horse-hoeing thrice	4 1 0		
July. Turnip seed, sowing and weeding	0 17 0		
	26 17 6		26 17 6

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No. XIV. 12½ Acres.

		£.	s.	d.		£.	s.	d.
	Rent, 16s. taxes and fences, 4s.	12	10	0	By 37 qrs. wheat, at 55s. -	101	15	0
Oct.	Ploughing bean land at 11s. -	6	17	6				
	28½ bush. wheat, 7s. 6d. -	7	13	9				
	Putting in and harrowing -	1	17	6				
Mar.	3 bush. clover-seed, 24s. -	3	12	0				
	Drilling, barrowing, rolling, &c.	1	17	6				
	Weeding - -	0	12	6				
		35	0	9				
	Gain -	66	14	3				
		101	15	0		101	15	0

No. XV. 11 Acres 3 Roods.

	£.	s.	d.		£.	s.	d.
Rent, 20s. taxes and fences, 5s. - -	14	13	9	By sheep pasture, 9 acres, 16s. -	7	4	0
2 loads dung, 2s. 6d. - -	0	5	0	3 loads hay, 42s. - -	6	6	0
Rolling and weeding - -	1	18	6	1 acre sold - - -	6	6	0
	16	17	3	27 bush. seed, at 40s. but allow ½ thrashing, and all mowing, £.4 16s.; and £.3 tithe -	46	4	0
Gain - -	49	2	9				
	66	0	0		66	0	0
Clover-seed, and putting in last year, £.11 8s. 3d.							

No. XVI. 7 Acres.

	£.	s.	d.		£.	s.	d.
Rent, 20s. tax and fences, 4s. -	8	11	6	By pasture, 35s. - - -	12	5	0
27 loads dung, 2s. 6d. - -	3	7	6	Loss - -	3	5	0
3½ bush. rubbish, clover, and rib -	0	17	0				
Rolling, tithe, and weeding -	1	11	6				
15 loads chalk rubbish - -	1	2	6				
	15	10	0		15	10	0

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No. XVII. 7 *Acres.*

	£.	s.	d.		£.	s.	d.
Rent, 20s. tax and fences, 4s. 6*d.*	8	11	6	By lucerne, mown thrice	17	10	0
Rolling, tithe, and weeding	2	3	0	Pasture, 2 acres the year	4	4	0
				After-pasture, 4*s.*	1	0	0
	10	14	6				
Gain	11	19	6				
	22	14	0		22	14	0

No. XVIII. $4\frac{1}{2}$ *Acres.*

	£.	s.	d.		£.	s.	d.
Rent, &c. 24*s.* 6*d.*	5	10	3	By 17 qrs. 4 bush. beans, 21*s.*	18	7	6
Jan. Ploughing, 12*s.*	2	14	0	Turnips	2	14	0
19 bush. long-pod beans, 3*s.*	2	17	0				
Mar. Dropping, harrowing, rolling	1	11	6				
Hand-hoeing once, horse-hoeing thrice	2	3	0				
Turnip-seed, sowing, and weeding	0	13	0				
	15	8	9				
Gain	5	12	9				
	21	1	6		21	1	6

No. XIX. 5 *Acres.*

	£.	s.	d.		£.	s.	d.
Rent, taxes, and fences, 24*s.* 6*d.*	6	2	6	By 22 qrs. beans, 25*s.*	27	10	0
Jan. Ploughing, at 13*s.*	3	5	0	By turnips	0	12	6
Mar. 2 qrs. 4 bush. beans, 24*s.*	3	0	0				
Putting in, harrowing, and rolling	1	7	6				
Hand-hoeing once, horse-hoeing thrice	2	7	6				
Turnip-seed, sowing, and weeding	0	12	0				
	16	14	6				
Gain	11	8	0				
	28	2	6		28	2	6

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No. XX. 6 Acres.

	£.	s.	d.		£.	s.	d.
Rent, taxes, and fences, 24s. 6d.	7	7	0	By 2625 bush. at 1s.	131	5	0
Jan. Ploughing, 12s.	3	12	0				
68 loads dung, 2s. 6d.	8	10	0				
Apr. Potatoes, 67 loads long dung, 2s. 6d.	8	7	6	Per acre 437 bush. prime cost 6½d.			
55 sacks seed, and cutting, 3s. 6d.	9	12	6				
Spreading, ploughing, planting, &c.	5	8	6				
June. Hand-hoeing and weeding, 9s.	2	14	0				
Horse-hoeing thrice, 6s.	1	16	0				
Nov. Digging 875 sacks, at 4d.	14	11	8				
Loading, carrying	1	7	4				
Sacks and bailiff	3	0	0				
Tithe	3	0	0				
	69	6	6				
Gain	61	18	6				
	131	5	0		131	5	0

No. XXI. 7 Acres 1 Rood.

	£.	s.	d.		£.	s.	d.
Rent, &c. 24s. 6d.	8	17	6	By 25 qrs. 6 bush. wheat, 55s.	70	16	0
Nov. Ploughing, at 12s.	4	7	0				
2 qrs. 2½ bush. wheat, 64s.	7	8	0				
Putting in and harrowing, 4s.	1	9	0				
Rolling, hand-hoeing, and weeding	2	12	6				
	24	14	0				
Gain	46	2	0				
	70	16	0		70	16	0

No. XXII. 10 Acres 3 Roods.

	£.	s.	d.		£.	s.	d.
Rent, &c. 24s 6d.	13	3	6	By pasture, at 55s.	29	11	3
Rolling 7s. and 3 preceding years	2	3	0	Gravel	3	15	0
Tithe and weeding	2	3	6				
	17	10	0				
Gain	15	16	3				
	33	6	3		33	6	3

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No. XXIII. 8 *Acres* 3 *Roods.*

	£. s. d.
Gain - - - -	8 4 0

No. XXIV. 4 *Acres.*

	£. s. d.
Gain - - - -	5 10 0

No. XXV. 22 *Acres* 2 *Roods.*

	£. s. d.		£. s. d.
Rent, &c. 20s. - -	22 10 0	By 66 qrs. wheat, 55s. -	181 10 0
Oct. Ploughing, at 12s. clover -	13 10 0		
Nov. 6 qrs. 1 bush. wheat, 60s. -	18 7 6		
Putting in and harrowing, 3s.	3 7 6		
Folding, 4 acres - -	3 0 0		
Rolling and weeding - -	4 10 0		
Sept. Broadsharing and harrowing a part - -	1 16 0		
	67 1 0		
Gain - -	114 9 0		
	181 10 0		181 10 0

No. XXVI. $4\frac{1}{2}$ *Acres.*

	£. s. d.		£. s. d.
Rent, &c. 20s. 6d. -	4 10 0	By 15 qrs. 6 bush. wheat, 55s. -	43 6 3
Nov. Ploughing, at 12s. clover ley	2 14 0		
$14\frac{1}{2}$ bush. wheat, at 7s. 6d. -	5 8 9		
Putting in and harrowing, 3s.	0 13 6		
Rolling and weeding -	0 13 6		
Sept. Broadsharing and harrowing part	1 4 0		
	15 3 9		
Gain - -	28 2 6		
	43 6 3		43 6 3

No. XXVII. 7 Acres.

	£.	s.	d.		£.	s.	d.
Rent, &c. 20s.	7	0	0	By 24 qrs. 5 bush. barley, 30s.	36	18	9
Dec. Ploughing potatoe land	3	10	0				
Feb. 19 bush. barley, 3s. 6d.	2	16	6				
Putting in, harrowing, and rolling	1	1	0				
Apr. Horse hoeing	0	7	0				
20lb. lucerne on 2 acres	1	10	0				
Sowing and hoeing by hand	0	16	0				
Sept. Broadsharing, harrowing, and burning weeds	3	3	0				
	20	3	6				
Gain	16	15	3				
	36	18	9		36	18	9

No. XXVIII. $9\frac{1}{4}$ Acres.

	£.	s.	d.		£.	s.	d.
Rent, &c. 20s.	9	5	0	By 25 qrs. 4 bush. pease. 32s.	40	16	0
Dec. Ploughing, sowing, and harrowing	7	16	6				
47 bush. grey pease, 4s.	9	8	0				
May. Rolling	0	7	6				
Weeding	0	9	6				
Aug. Ploughing, harrowing, and rolling	7	4	0				
$4\frac{1}{2}$ gal. turnips, and sowing	0	11	3				
1lb. cabbage, and sowing	0	3	3				
Nov. Pricking out plants	0	12	6				
	35	17	6				
Gain	4	18	6				
	40	16	0		40	16	0

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No. XXIX. $21\frac{1}{2}$ *Acres.*

	£.	s.	d.		£.	s.	d.
Rent, &c. 20s.	21	10	0	By 120 qrs. 7 bush. barley, 30s.	181	6	0
Mar. Ploughing, 10s. 8 qrs. 2 bush. barley, 28s.	11	11	0				
Putting in, harrowing, and rolling	4	6	0				
June. Rolling again for wire-worm	2	8	0				
	39	15	0				
Gain	141	11	0				
After beans.							
	181	6	0		181	6	0

No. XXX. $8\frac{1}{2}$ *Acres.*

	£.	s.	d.		£.	s.	d.
Rent, &c. 20s.	8	10	0	By 27 qrs. beans, 22s.	34	14	0
Ploughing, 12s.	5	2	0	Turnip feed	1	1	0
Feb. 4 qrs. 2 bush. Mazagan beans, 24s.	5	2	0				
Putting in, harrowing, and rolling	2	11	0				
Hand and horse hoe weeding, turnip-seed, and sowing	4	11	0				
Sept. Ploughing, 12s.	5	2	0				
	30	18	0				
Gain	4	17	0				
	35	15	0		35	15	0

No. XXXI. 2 *Acres* 3 *Roods.*

	£.	s.	d.		£.	s.	d.
Rent, &c. 20s.	2	15	0	By 5 loads sainfoin, 42s.	10	10	0
Rolling, tithe, and weeding	0	14	0	4th year.			
	3	9	0				
Gain	7	1	0				
	10	10	0		10	10	0

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No. XXXII. 9 Acres.

	£. s. d.		£. s. d.
Rent, &c. 20s.	9 0 0	By 9 loads sainfoin, at 42s.	18 18 0
Rolling and tithe	1 17 6		
	10 17 6		
Gain	8 0 6		
	18 18 0		18 18 0

No. XXXIII. 6 Acres.

	£. s. d.		£. s. d.
Rent, &c. 20s.	6 0 0	By 8 loads sainfoin, 42s.	16 16 0
Rolling, and tithe	1 5 6	174 bush. potatoes, 1s.	8 14 0
14 loads dung, 4½ sacks potatoes, and other expences, planting ¾ acre	3 9 6		
Hand and horse-hoeing, and weeding	0 6 6		
Digging 58 sacks, at 4d.	0 19 4		
Other expences, and tithe	0 18 0		
	12 18 10		
Gain	12 11 2		
	25 10 0		25 10 0

No. XXXIV. 3 Acres.

	£. s. d.		£. s. d.
Rent, &c. 20s.	3 0 0	By 5 loads sainfoin, 42s.	10 10 0
Tithe and rolling	0 13 0		
	3 13 0		
Gain	6 17 0		
	10 10 0		10 10 0

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No. XXXV. 7½ *Acres.*

		£. s. d		£. s. d.
	Rent, &c. 20*s*. - -	7 10 0	By turnips, at 42*s*. - - -	16 16 0
	64 loads dung, and mould, 2*s*. 6*d*	8 0 0	Loss - -	36 2 6
June.	Ploughing thrice, 12*s*. -	14 6 0		
	Harrowing, rolling, raking, burning, seed, and sowing -	5 12 0		
	113 loads dung, and mould, 2*s*. 6*d*. - - -	14 2 6		
	Spreading ditto, and ashes -	0 16 0		
	Hoeing - - -	2 12 0		
		52 18 6		52 18 6

No. XXXVI. 28½ *Acres.*

		£. s. d.		£. s. d.
	Rent, &c. 20*s*. - -	28 10 0	By 98 qrs. 36 bush. oats, 18*s*. -	88 11 0
	Broadsharing, harrowing, rolling, burning, and spreading ashes - - -	9 5 0	13 qrs. 1 bush. beans, 22*s*. -	14 8 6
	Ploughing in winter, 12*s*. -	25 2 0		
Feb.	Putting in 24½ acres oats -	4 5 9		
	13 qrs. oats - -	13 13 0		
	Putting in 4 acres beans -	1 0 0		
	2 qrs. beans - -	2 8 0		
	Keeping off crows, and rolling	1 5 3		
	Hand and horse-hoeing, and sowing turnips -	2 16 6		
		88 5 6		
	Gain - - -	14 14 0		
		102 19 6		102 19 6

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No. XXXVII. 6 Acres.

		£.	s.	d.		£.	s.	d.
	Rent, &c. 20s.	6	0	0	Feed on tares, self-sown, and turnips	1	0	0
	Ploughing and harrowing tare land	1	10	0	7 cwt. of burnet-seed, 40s.	14	0	0
	Rolling burnet	0	4	0	723 bush. potatoes, 1s.	36	3	0
	Turnip-seed, and sowing 2 acres	0	2	6	27 picked	0	18	0
Apr.	Potatoes, 54 loads dung, 2s.	5	8	0				
	20 sacks, and cutting, 3s. 6d.	3	10	0				
	Ploughing, planting, harrowing, and rolling	2	2	0				
July.	Hand-hoeing, 8s. weeding, 1s.	0	18	0				
	Horse-hoeing twice, at 2s.	0	8	0				
	Mowing and thrashing burnet	0	17	0				
	Tithe potatoes, and ditto	1	17	6				
Nov.	Digging 241 sacks potatoes, 4d.	4	0	4				
	Loading and carrying	0	8	2				
	Sacks, and bailiff	1	2	6				
	Picking after plough	0	4	0				
		28	12	0				
	Gain	23	9	0				
		52	1	0		52	1	0

No. XXXVIII. 16 Acres.

	£.	s.	d.		£.	s.	d.
Rent, &c. 20s.	16	0	0	By 36 loads sainfoin, 42s.	75	15	0
Rolling, weeding, and tithe	3	16	0				
	19	16	0				
Gain	55	19	0				
	75	15	0		75	15	0

No. XXXIX. 8 Acres.

	£.	s.	d.		£.	s.	d.
Rent, &c. 24s. 6d.	9	16	0	By pasture	16	16	0
Fourteen trees planting	0	14	0	Fruit sold	2	0	0
Tithe and weeding	1	4	0				
	11	14	0				
Gain	7	2	0				
	18	16	0		18	16	0

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No. XL. 3 *Acres* 1 *Rood.*

		£.	s.	d.		£.	s.	d.
	Rent, &c. 20*s.*	3	5	0	By 5 qrs. 4 bush. wheat, 55*s.*	15	2	6
Oct.	Ploughing, 12*s.*	1	19	0				
	Putting in wheat sown	0	9	9				
	8 bush. wheat	3	0	0				
	Rolling and weeding	0	7	0				
		9	0	9				
	Gain	6	1	9				
		15	2	6		15	2	6

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RECAPITULATION.

Nos.	Acres.	Crop.	Gain. £.	s.	d.	Loss. £.	s.	d.
No. I.	22	Wheat	78	3	3			
II.	18½	Oats	84	7	6			
III.	4¼	Let	9	18	6			
IV.	1½	Fruit and pasture	5	3	0			
V.	5¼	Pasture	7	4	0			
VI.	11	Clover	29	3	6			
VII.	11¾	Ditto	15	5	0			
VIII.	4¼	Potatoes	29	0	6			
IX.	19¼	Wheat and potatoes	89	10	6			
X.	13	Potatoes	74	5	0			
XI.	6½	Sainfoin	8	10	6			
XII.	8½	Pease	—	—		13	11	6
XIII.	9	Beans	—	—		4	10	6
XIV.	12¼	Wheat	66	14	3			
XV.	11¾	Clover	49	2	9			
XVI.	7	Ditto	—	—		3	5	0
XVII.	7	Lucerne	11	19	6			
XVIII.	4½	Beans	5	12	9			
XIX.	5	Ditto	11	8	0			
XX.	6	Potatoes	61	18	6			
XXI.	7	Wheat	46	2	0			
XXII.	10¼	Pasture	15	16	3			
XXIII.	5¼	Let	8	4	0			
XXIV.	4	Ditto	5	10	0			
XXV.	22½	Wheat	114	9	0			
XXVI.	4½	Ditto	28	2	6			
XXVII.	7	Barley	16	15	3			
XXVIII.	9¼	Pease	4	18	6			
XXIX.	21½	Barley	141	11	0			
XXX.	8½	Beans	4	17	0			
XXXI.	2¼	Sainfoin	7	1	0			
XXXII.	9	Ditto	8	0	6			
XXXIII.	6	Ditto, and potatoes	12	11	2			
XXXIV.	3	Sainfoin	6	17	0			
XXXV.	7¼	Turnips	—	—		36	2	6
XXXVI.	28½	Oats	14	14	0			
XXXVII.	6	Potatoes, and burnet	23	9	0			
XXXVIII.	16	Sainfoin	55	19	0			
XXXIX.	8	Pasture	7	2	0			
XL.	3¼	Wheat	6	1	9			
	380		1165	5	2	57	9	6
			57	9	6			
			1007	15	8			

Chicory seed sold from 2 acres of ground in 1793, 8 cwt. 2 qrs. £.89 12s.

To examine whether the team expences are adequate.

	£.	s.	d.
Expences, ploughing, * &c. so far as they can be ascertained, amount in these accounts to	271	11	9
	4) 271	11	9
As this includes labour, deduct ¼ - - - - -	67	17	11
At £16. a horse - - - -	16) 203	13	10
	12 horses		

But manuring not included, nor harvest.

Loads of manure		
	174	
	252	14 cart ones kept
	2	4 others
	27	4 cows.
	15	
	68	
	67	
	14	
	64	
	113	
	796 suppose 6*d*. a load, it is £19. 18*s*. or one horse and a quarter.	

Note by the Farmer—The great gain that appears in the last 5 years may probably arise from the following causes:

1. Substituting potatoes for turnips.
2. No fallows.
3. Very sparing tillage, sometimes only 4 ploughings in 4 years.
4. The high priceof corn.
5. Perhaps drilling may had have some effect.
6. Discontinuing the hop plantations.

REMARKS.

The object which renders this ledger most interesting is, its being a *field account*; by entering to each field the expences and produce, the farmer is enabled by recurring to his ledger, to satisfy himself of the comparative profit of different courses of crops; of manuring; of products locally beneficial; of arable and pasture, and various other inquiries, which an attentive farmer must be desirous of ascertaining, and which can be done only by this method. It is difficult to effect where barns are not very numerous, or the fields large: the method in this case has been to register every load of

* My farming horses, exclusive of the work on the farm, earn from £50. to £100. per annum, carting bricks, gravel, &c.

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corn in the straw, and estimate the produce; when thrashed he can correct this estimate, having the total produce of each sort of grain ascertained, by apportioning it in a division amongst the fields according to the loads in the straw.

This gentleman supposes that the chaff and straw of his crops will pay harvesting, thrashing, carriage, and market expences: this may probably be accurate in the vicinity of a great town like Rochester, Stroud, and Chatham, and where there are barracks full of troops; but in other situations such an estimate would be a source of error; and in any situation, it leaves a most material question unsatisfied, *viz.* the profit and loss of live stock. The aftergrass of sainfoin, &c. is also supposed to pay for mowing, making, carting, stacking, carriage, &c. of hay, which it would not nearly equal in many situations. This, with the acreable estimate of pasturage, strike cattle and sheep quite out of the question, in the books of a farm on which there appears to be five or six hundred pounds laid out in those articles. There is no cattle or sheep account in the ledger.

The whole expence of the team of fourteen horses is also entered by estimate, in the proportion of ten to twelve shillings an acre for ploughing; and labour being included with these charges, renders it difficult to separate them. It has been however attempted. There should certainly be a team account, and the expence divided amongst the various sorts of work. The manure is charged at 2*s.* 6*d.* a load, which may or may not be the fact. A farm yard account is necessary where accuracy is desired.

There is no article of wear and tear of implements, it being included in tillage and cartage, and would perhaps be found, if ascertained, to require a larger allowance.

The bailiff appears no where but in the article of potatoes, where sacks and bailiff's attendance are united in one charge.

The profit for five years has been,

In 1793	-	£.975	2	4
1794	-	953	6	6
1795	-	1086	14	10
1796	-	1197	15	6
1797	-	1107	18	11
		5)5320	18	1
Average	-	1064	3	7

Or per acre on 380 acres, £2. 16*s.* 0*d.* amounting to about three rents.

XXVI.

On CLAY *and* MARLE. *By Mr.* JOSIAH RODWELL, *of Livermere, near Bury, Suffolk.*

MY LORDS AND GENTLEMEN,

BEING informed that you have voted to an excellent farmer in Surry, justly celebrated for his exertions, a mark of your approbation, it has been suggested to me by some neighbours, who have for 28 years viewed what I have done to improve a poor and almost waste tract of land, to send you an account of my operations, which I have complied with, trusting that this is the most likely method of inducing others to examine well their soils, and whatever may be found beneath: my practice is confined and limited, but your attention can spread any knowledge throughout the kingdom, and render the exertions of an individual beneficial to a whole nation.

I wish at present to call your notice to the effect of digging and spreading marle and clay upon poor dry heaths producing fern and gorse, but chiefly ling; originally of small value, at best yielding but a scanty support to ill fed sheep.

The Rev. Mr. Lathbury's father, about 50 years ago, was offered any quantity of this heath at 4*d*. per acre: the farm on which I have been working consists of 1400 acres, 700 of which were of this sort of heath; it had been occupied by my predecessor, Mr. Garnham, for 36 years, at the rent of £.140, and never more than £.150, the landlord (Bapt. Lee, Esq.) paying tithe, nor did Mr. Garnham at that rent do much more than make a living in it. In 1771, it was valued for raising the rent, and £350. a year demanded, not tithe-free, at which rent Mr. Garnham refused it, as did several other farmers, who examined the land; and when I engaged at that rent, I was pronounced a ruined man by most of my acquaintance who knew the farm. I had a lease of 13 years.

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My operations at first were to enclose with thorn hedges, marle or clay, and break up 300 acres of the heath; and in the first seven years of the lease I finished what I meant to improve in that term; I marled or clayed 600 acres, at 70 loads an acre, being 42,000 large tumbril loads. In this work I employed three teams, two of my own, and one I hired for several years. It is severe work, and the second year I lost nine horses, attributed to feeding on pea straw from the new broken heath, a circumstance that deserves the attention of improvers.

In the 11th year of my lease I applied to my landlord for a renewal; on which the farm was valued again by Mr. Hare, the surveyor at Peterbro', and I took a fresh lease of 15 years, to commence at the termination of my old one, at the rent of £400.

I immediately clayed and broke up 200 acres more, at 100 loads an acre, 40 bushels per load, inclosing all with quick hedges, and ditches 5 feet wide, and 4 deep; after this, I improved 100 acres more in the same manner.

In the two leases of 28 years, I clayed or marled 820 acres; and I have clayed or marled so much over the second time, at 70 loads an acre, that the quantity I have carried in all, is very little short of 140,000 loads.

Upon taking a third lease, I was in 1798-9, particularly steady to this work, and in 49 weeks and 3 days carried 11,275 cubical yards, paying by measure of pits, and not by loads, which were filled and spread by 4 men and a boy, and carted by 6 horses and 2 tumbrils.

In this business of carrying clay or marle I have practised handbarrowing; the men can make good earning at 10*d.* a yard, wheeling it 30 rod; and down to 7*d.* a yard at shorter distances; and I am much inclined to think, that if we had workmen used to the operation, and handy at it, like those employed in navigations, that this method would be of all others the cheapest, especially on heavier soils. But by far the greatest part I have done by tumbrils, the expence of which put out is 5*d.* a yard for team, and 2½*d.* a yard for labour, and paying for laying picks, wedges, &c. also for stones that rise, increase the whole expence to 8*d.* per yard, which is at least ½*d.* per yard cheaper than I can do it with my own teams; the reason of which is, that the man who contracts with me drives his own horses, and looks after them; at 8½*d.* per yard, 140,000 yards have cost me £.4958, excepting the small proportion *hired* at ½*d.* a yard lower.

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I come now, my Lords and Gentlemen, to mention a few circumstances which I hope may tend to render this paper useful to others, not having the experience which I have acquired: I shall use but few words, but they shall be founded on positive experiment or attentive observation.

Clay is much to be preferred to marle on these sandy soils, some of which are loose, poor, and even a black sand. By clay is to be understood a grey clayey loam, some of it brick earth, and all has with vinegar a small effervescence. Marle is a white greasy, chalky substance, that effervesces strongly with acids: I make a universal rule, on a second improvement, to lay clay on the fields marled before, sometimes marle where clay was spread before; but this not general, as clay answers best on the whole.

In the the tillage of improved lands, I am attentive never to over-crop. My usual rotation has been,

1. Turnips.
2. Barley.
3. Clover, ryegrass, and trefoil one or two years.
4. Peas.
5. Wheat.

On some I have sown oats on the layer, and omitted peas and wheat, which is more favourable to the land; and I should with longer leases have done more so. Peas, it is true, are an improving crop; but the two coming together are perhaps working the marle too quickly. I have broken some heath up and sowed oats, and even wheat, designing to improve on the stubble; but sowing 4 bush. oats I have gained but 10, and of wheat, not more than 3 coombs* at first breaking.

My crops, by managing attentively, have been good; I have had $11\frac{1}{2}$ coombs of barley an acre, and even 14, and these over large fields; I have had 7 coombs an acre of peas over six score acres, and fine wheat after them.

On 90 acres, clayed 100 loads an acre, I have had after two crops, the one turnips, the other barley, cole-seed, and sold it on the ground for 1000 guineas; then turnips, a famous crop, followed by barley on 75 acres, 16 coombs an acre; and by oats on 15 acres (poorer-land) 10 coombs an acre. These crops are for the soil *great*; but in general my products have been highly to my satisfaction.

* The coomb is $\frac{1}{2}$ a quarter.

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In regard to other manures, my farm has had the fold of from 40 to 48 score sheep; they manure, one year with another, 150 acres; and I am never without bullocks for increasing the farm yard dung. I top fold wheat from the begining of November till Christmas, and even till February, and venture it on clayed land at the hazard of frosts at sun rise, which sometimes injure it much, but the effect in general is great. Of all mucking, that for turnips pays me best, particularly on clayed land: I know many farmers in Norfolk prefer laying it on for wheat, the turnips to have it at second hand; but I prefer the other method. And let me note, that I use long muck to choose, which I think far better than turning, mixing, and rotting muck; here also are different opinions; I speak only from my own experience. Wheat stubble, I think, should always be whelmed in for turnips.

I once ploughed in a fine crop of buck wheat for turnips, and the crop was so much worse than the rest of the field, that they were not penned regularly for the sheep; yet, with this disadvantage, the barley following was better than where the turnips were much superior.

I have dibbled largely and with good success, and think it the best method; and I approve much of the drill roller as the next best.

In tilling these improved sands, it is a common observation in Norfolk, that shallow ploughing is necessary to preserve *the pan*: I have not found this the case here; but, on the contrary, that the clay and marle works the better the more soil it has to incorporate with.

Having thus stated shortly, the general managements of my improvements, I now come, with your permission, to the general result. Rent will speak this:

It is stated, that 28 years ago, the rent of farm was £150. a year tithe free, and that it was then raised to £350. a year, tithe payable. I may venture to assert, that, at that rent, without improvement, it might have so stood on my landlord's rent-roll till doomsday, for a mere living could only be made on it even in good times. But upon my taking the third lease, commencing 1799, it was raised to £600. a year, at the same time that to the full value of £100. a year was taken from it; in other words, the present rent is £700. a year. Thus, while, with the blessing of God, I have done well in the farm, and have put five children into the world out of twelve living, I have added £350. a year to the value of the estate, which, at thirty years purchase, is £10,500.: and, relative to the public at large, I may venture to assert, that these 1400

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acres have, in the last 28 years, yielded £30,000. worth more of corn, meat, and wool, than they did in the 28 preceding. A fact which tends strongly to shew the national importance of improvements in agriculture, and also the wisdom of establishing a public Board for promoting and encouraging such exertions as may be deemed laudable.

I have the honour to be,

My Lords and Gentlemen,

Your most obedient servant,

JOSIAH RODWELL.

Livermere, near Bury, Suffolk,
Nov. 18th, 1799.

(The Gold Medal of the Board was voted to Mr. Rodwell for this communication.)

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XXVII.

On Provincial Farming Societies.

The following Circular Letter was addressed by the President of the Board of Agriculture, to many Noblemen and Gentry in different parts of the kingdom.

Board of Agriculture, No. 32, Sackville-Street,
6th May, 1799.

Sir,

The Board of Agriculture having come to the determination to promote the institution of small Provincial Agricultural Societies, as much as may be in their power, in every part of the kingdom, pursuant to the subjoined proposition of the President, I am requested to apply for your assistance in carrying the plan into execution. We have no doubt but that your influence at

will effect it in such a manner as to meet the warmest wishes of the Board.

The design is to collect together the most intelligent farmers, breeders, graziers, wool-staplers, &c. under the eye, and in the society, of such land proprietors as may be disposed to promote the institution.

No person can be more proper than yourself, to become the first President of such an institution; and to name, at the first meeting, an active, resident, intelligent person, Vice-President. Your answer will much oblige,

Sir,

Your obedient servant,

Somerville, *President.*

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Extracts from the Minutes of the Board of Agriculture, of a Meeting dated April 16th, 1799.

The President, in consequence of the notice given of a proposition relative to the establishment of District Societies, then addressed the Board:

"So indispensably needful is the institution of Farming Societies, and so obvious their application, that very few words will suffice in recommendation of the measure I now do myself the honour to propose. They must embrace few, but those few, the most leading objects of farming improvement; they will hold communication with the Board of Agriculture, and must be the points of intercourse between the Board, which ought to be considered the fountain-head of all theoretical knowledge, and the common country farmer, who reads nothing. From the want of this medium, the Board has hitherto stood as it were insulated, and its communication with those whom it was principally intended to instruct, has been beyond measure precarious.

"If well-grounded theory be not followed up, by prompt and substantial practice, it falls to the ground, and is forgotten: now to effect this, we must look either to the landlord, or to the active and intelligent, of the higher class of farmers. Were landlords early taught this mysterious trade, as in truth they, for their own interest, ought; did they reside altogether on their estates, did they trust little to servants, and had they a spare capital ready to apply to great objects of improvement, no doubt instruction would with the best effect come from them; but as things are, little doubt remains as to the channel through which great improvements must generally go forth.

"In a political light, something heretofore might have been feared from the institution of numerous societies of any description: but little cause can here be apprehended, when we contemplate the decided loyalty of the bulk of the English people, the acknowledged exertions in particular, of this class of men, the Yeomen of Great Britain; the few meetings needful, (four annually at the utmost), and the care which will be had to give the direction of them to persons in all respects well qualified to promote an undertaking of such magnitude.

"I therefore take the liberty of proposing, that these Societies be formed, wherever fit men be found to give them protection and effect; that they hold at the most public and convenient times, quarterly meetings; and I take the liberty of laying before the Board a list of such persons, and places, as have already suggested themselves.

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"Subcriptions may amount from five shillings to one guinea per annum, which sum cannot deter farmers of any class from putting themselves in the way of what I trust will shortly appear most materially to their advantage. Forty members at five shillings only, would establish a fund adequate to the first purposes of such a plan. In this case, three premiums only, would cover the leading objects of farming improvement.

"One for the best Cow and Calf:

Symmetry of shape, quickness of proof, and powers of the particular breed to labour as oxen, or to cream and butter, per acre, to be absolute as to preference.

"One for the best Ten Ewes:

Symmetry of shape, quickness of proof, and comparative value of wools of the different breeds, to be absolute as to preference also:

and one for the best two days work in ploughing, with a small bounty to the best ploughman, for the best two hours work: these two objects to be decidedly distinct from each other, for many reasons. Should the Society amount to double this number, the premiums will be greater in value, but ought still to be confined to these most essential objects, and would probably have more effect in the shape of some permanent and conspicuous object, than if paid in money. When the subscription to these Societies shall be more considerable, their objects of encouragement may be more extended, on the plans of many provincial societies already established, whose benefits are strongly felt wherever they are found. The annual Volume of the Board of Agriculture, in any form the Board shall think most adviseable, may be circulated with the best possible effect through the channel of these Societies; in return for which, the Board will most readily supply them with implements, models of implements, or of fences, and also of such productions foreign to that particular district, as, after deliberate investigation, it shall deem worthy of culture. In numberless other cases, which it would be tedious here to enumerate, the Board of Agriculture may render the farming world, through these Societies, the most essential advantages; to such an extent as, I am well persuaded, will leave regret in the mind of no liberal man whatever, that such a measure has been carried into the fullest effect."

[*Since the forwarding of the letters herein mentioned, we have the pleasure of communicating, that on this plan, many Societies are already formed, and, with some little exertion on the part of those who have personal influence in their neighbourhood, they will become general throughout the kingdom.*]

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XXVIII.

On the IMPROVEMENT *of* BRITISH WOOL.

The following Letters, addressed to the Rt. Hon. LORD SOMERVILLE, *are selected from a very numerous Correspondence, as tending to throw some light on subjects either connected with that important one under discussion, or treating on parts of it hitherto unnoticed.*

MY LORD,

I AM happy to hear the plan for improving the British wool goes on well, and have to thank your Lordship for your attention to the Southdown breed of Sheep. Shall be happy in sending the Board some Southdown wool for an experiment. From what I could ever learn from the manufacturers, cloth equally fine, could be made of the Ryland, or Southdown wool, as of the Spanish, but not equally soft and pleasant to feel. I am well persuaded that wool is as capable of being improved by attention, as the carcase, perhaps more; as the one has been much more attended to than the other, by most breeders; I have ever thought both deserving attention. Return the samples of cloth, with many thanks.

And am, my Lord,

Glynn, 5th April, 1799. Your Lordship's obliged humble servant,

JOHN ELLMAN.

MY LORD,

The lock of Ryland wool is very fine and silky, soft to the touch; what is certainly wanting in the Southdown breed: wool has been much neglected by our first sheep breeders; and I once remember to have heard B--kew--ll say, (in speaking to him on the quality and quantity of wool, which he seemed to have totally neglected) that he wished to breed a sort of sheep that produced no wool at all, a sort of doctrine I could not understand. Your Lordship well knows, that great attention has of late been paid to the thinness of skin both in cattle and sheep, an idea I do not altogether correspond

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with; I have seen cattle with thick hides often very fat very quick, but I believe, that is not the case generally; but nature most certainly has formed thick skins for some wise purpose; and, I believe, those who pay great attention both to cattle and sheep, will find the animal with the thickest skin the most hardy in constitution, and will bear the severity of seasons better than those of a thin skin, a matter not undeserving attention in breeders, particularly in exposed situations; and it ever has been my opinion to drop between the two extremes.——And am, my Lord,

Your Lordship's

Glynn, 25th April, 1799. Obliged humble servant,

JOHN ELLMAN.

MY LORD, *Bath, April 26, 1799.*

I have received your Lordship's several letters of the early part, of the 23d and 25th inst. The former was duly laid before the general meeting on the 9th, as will appear by copy of the Minute inclosed, and by copy of the article inserted in the public advertisement of said meeting. By these copies it will appear to your Lordship, that the subject came under the consideration of the meeting, how far, and in what manner, an important improvement may be best made in the article of *English wools?* It has been a subject very frequently touched upon incidentally in the meetings of this Society, and a subject which many men have much reflected on. I doubt whether the expectations of the most intelligent men among the manufacturers, are quite so extensive as your Lordship's, respecting the possibility of doing with a very diminished quantity of Spanish wool, without trenching on the supply of the other numerous woollen manufacturers of the kingdom. However, all agree that important improvements in the different *kinds* of wool, (as to fineness of *pile*), and in the quantity, by attending to proper selection of young rams and ewes, in every district, and almost in every country parish, may be made; and all agree also with your Lordship, that the prospect of the time demands it. Considerable notice will be taken of this subject in the Society's 9th volume, now in the press; and it is hoped, that the more favourable proceedings of the Board of Agriculture will give sanction to the opinions of this western association.

Your Lordship may depend on my bringing the last proposals, contained in your Lordship's letter of yesterday, before the next general meeting; and that due notice will be taken of the same. Also, that immediate information will be transmitted to

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you of the result; which, I doubt not, will be the most agreeable to the best views and measures of the Board.

For the Society, with the greatest respect,

WM. MATTHEWS, Secretary.

Rt. Hon. LORD SOMERVILLE.

From the Journal.

MIN. 3. Another letter from Lord Somerville, the President, was received and read, announcing his intention of moving the Board of Agriculture, To become active in promoting the growth of finer wool in Britain, on a scale sufficiently extensive to check the exorbitant demand of foreigners for Spanish wool, &c. Thanks are again voted to his Lordship, and the Secretary to assure him that the Society will be ever ready to receive communications from his Lordship, as head of the Board of Agriculture, or as their own President.

From the public Advertisement.

In consequence of a written address from the President, Lord Somerville, the extreme advance in the price of Spanish wool was taken into consideration: and altho' it appeared to this meeting difficult to devise any speedy and efficacious means, whereby LARGELY to improve the quality and increase the quantity of the finer native wools, in aid of the cloth manufactures of this country, and that much regard is due to the supply of other woollen manufactures, which consume all the coarser and longer combing wools; it is a subject which requires, and may in future more urgently require the attention of the people of England: at any rate, an immediate care in the most considerable breeders of the various races of sheep, seems very desirable, to select and save, for breeding, the largest possible number of the *finest wooled* young rams and ewes; and it is hoped much of this useful care may be exercised, consistently with the necessary attention to the carcase. This brief and seasonable recommendation in the present critical juncture, is expected to be followed up by the further earnest attention of this Society.

Extract.

June 14, 1799.

You desired the cloths might not be heavy in wear; we have accordingly milled them to a firm, but not clumsy, quality, and will, we believe, wear as pleasant in a

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coat as the finest Spanish Broad, and wear as long as any gentleman requires. Beg Mr. Chadwick and yourself will examine the first cloths which come to hand, and if you think they can be altered for the better in any point, will endeavour to follow your directions in the cloths not sent off: but they are, to the best of our judgment, good and beautiful cloths, and will give satifaction to the wearer.* We were highly pleased with reading that our gracious Sovereign, who is, in the strictest sense, the Father of his people, appeared on his birth-day in a coat manufactured of wool the growth of his native soil.

My Lord *Hereford, July 5, 1799.*

I did myself the honour of writing to your Lordship some time since, in consequence of your address to the Board of Agriculture last November; but as I have not had the honour of any answer, I am afraid it never reached your hands.

I am induced to trouble your Lordship again, from what you delivered to the Board as President last May. That good cloths may be made without any mixture of Spanish wool, I have long been convinced; and that in those more sheltered parts where the Spanish rams have crossed our own breeds, full as good as those mixed with imported wool. In two other covers, I send you patterns of cloths made here from my own wool, spun by the children at Mrs. Johnes's school, wove by our coarse weavers, and clothed by our still coarser fullers.†

* These cloths, more particularly laidies cloth, were shewn to Her Majesty, who not only expressed her approbation, but was pleased to give a large order for blue laides cloth of British growth. Such an example, we trust, will quiet the tender scruples of those few gentlemen who still fear native cloths may be too coarse and hard for their use.

A correspondent in town, to whom these gentlemen, with no common share of liberality, have acknowledged themselves benefited by many hints he had given as to the working and shearing cloths, speaking of the ladies cloth above mentioned, says, "Of the enclosed pattern, I beg again to say, that I have shewn it to some very good judges, who say it is one of the best ladies cloths they have ever seen, and will prove better both in look and wear, worth one guinea and a half per yard, than the greater part of ladies cloths at eighteen shillings: this is a great improvement; because, if such ladies can be made of this quality, we are sure those of stouter texture must succeed. The price of this laidies cloth is £1. 1s. per yard." Patterns of these cloths have been sent to the Board of Agriculture, and Bath Society.

† To few individuals in the kingdom is the public more indebted than to this gentleman. His patterns, No. 1 and 2, are good and fine cloths.

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I am in hopes that some good clothiers will at last think of settling in this wool country, where water may be had any where to work machinery, and where provisions are so comparatively cheap. The saving in the carriage alone, of the wool to the manufactories, would amply repay them.

On the other side, I have stated the price of each piece of cloth; and cheap as it may seem, machinery would have made it much cheaper. Should your Lordship wish further details, I shall be very happy to give them.

I am,

My Lord,

Your most obedient humble servant,

T. Johnes.

No. 1. Dyed in the wool; no Spanish mixture; it is but yard wide, for our weaver's looms will not hold broad cloth width. 25 lbs. of wool made 40 yards of cloth, at *1s.* per lb.; spinning *2s. 6d.* per lb. weaving *6d.* per yard; clothing *1s.* per do.

No. 2. A mixture from some Spanish sheep and Spanish rams, that His Majesty was so kind to give me. They were too nice for this country; had the foot rot almost continually: The same prices as No. 1.

No. 3. A mixture as above, for waistcoats; the same prices for spinning, &c.

No. 4. No mixture; servant's livery cloth, dyed in the wool. 1 lb. of wool makes a yard; wool *1s.* per lb. spinning *1s.* per lb. clothing *1s.* per yard; one ounce of indigo to a pound of wool, for dying, *6d.* per ounce; weaving, per yard, *4d.*—*3s. 10d.* per yard.

No. 5. No mixture; livery cloth, dyed in the cloth; same prices as No. 4.

No. 6. Waistcoats, same in all respects as No, 3.

No. 7. Flannel, wool of the country; wool and every thing included, *2s. 8d.* per yard.

No. 8. Livery cloth; dyed in the cloth, same prices as No. 4 and 5.

My Lord, *Pendeford, July 27, 1799.*

I have sent by this day's mail coach, six samples of wool, in consequence of your Lordship's desiring samples of Morf wool.

No. 1. Spanish wool from Mr. Blew, clothier, Stourbridge, Worcestershire.

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No. 2 Morfwool from Mr. Harris, Penn, near Wolverhampton, from sheep brought from Morf, Michaelmas, 1798.

No. 3 and 4. Mr Edwards, Farmcott, near Bridgenorth, Morf wool from his own flock.

No. 5. Ewes wool, from Mr. Grosvenor, Farmcott.

No. 6. Rams wool from ditto.—Mr. Grosvenor's wool is, I believe, of the very first quality of Morf wool.

I have also enclosed a small pattern of cloth, manufactured entirely of Morf wool, by Mr. Blew, clothier, Stourbridge.

The average price of Morf wool this present season, I am assured, has not fallen short of 2*s.* 6*d.* per lb. wt. It is, I believe, entirely bought up, and none left in the grower's hands; the prices of the finest lots are difficult to come at, owing to a confidential secrecy between the buyer and grower.

Mr. Edwards assisted me in calculating the extent of Morf, and its produce of wool; the wastes he estimates at 3600 acres, the total number of sheep summered thereon at 15,000; the fleeces vary from 7 to 10 to the stone of 14 lb; upon a moderate estimate he believes that the produce of this common is not less than 15*s.* per acre, per annum, in wool only, but thinks no other produce ought to be placed to its account, as some assistance is required towards supporting the sheep in winter: several other of the Shropshire commons produce excellent wool, but none equal to this by about 6*d.* per lb. in value.

The Morf fleece is almost wholly fine, with a very small proportion of breechings or daglocks. The wool-growers I applied to all think it might be an experiment worth trying, whether any improvement could be made, either in quantity or quality by a cross with the Spanish; and were unanimous in desiring me to request to be informed whether your Lordship, or the Board, could furnish them with a ram for such experiment, upon easy or reasonable terms; they would naturally expect one carrying finer wool than their own. If any Morf ewes should be desired for any gentleman, they are very easy to be obtained, and at low prices. The ewes, when rejected, at 4 or 5 years old, are sold at 12*s.* to 15*s.* per head, about Michaelmas, and I suppose, a select lot of prime ewes may be bought at 16*s.* per head, or thereabouts; but they should be applied for early in September, before the sale commences: they weigh, when fat, from 10 to 14 lb. the quarter, but an aged fat ram often 16, or more. I find I was not correct in my former description of these sheep, owing to having, some years ago, seen

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a lot of polled white faced ones in Bridgenorth fair, which were stated to me as Morf sheep; they have generally small horns, with speckled or darker coloured faces and legs, but are sufficiently distinct from other breeds; the horns are stated as necessary to raise the furze from the snow, or push it aside from the grass. A gentleman in this neighbourhood procured the last year, 20 ewes from Ross; the wool of which he has sold at 2*s*. per lb. only; this should prove the superiority of Morf wool. Hoping this account, and the specimens, may be, in some degree, satisfactory, I remain,

My Lord,

Your Lordship's obliged humble servant,

WILLIAM PITT.

MY LORD, *Pendeford, August 14, 1799.*

In answer to Mr. Vigne's letter of 9th inst. I send you what I know of the price of Leicester wool. I have no direct communication with the Leicestershire wool growers on this subject, but was some time ago informed by a Staffordshire farmer, bordering on Leicestershire, that he had been offered, and had refused, 9*d*. per lb.; and very lately, a wool-stapler from Bromsgrove, Worcestershire, called on some of my neighbours, who grow Leicester wool as well as myself, and bought our year's produce at 21*s*. 6*d*. per todd of 28 lb.; this wool stapler, I am informed, manufactures it no farther than yarn, which is afterwards sent to the stocking-looms at Leicester. My sheep were originally bought at Leicester fair, and were once crossed with a ram of Mr. Astley's; their average produce is a little over 7 lb. of wool each. One of my neighbours, (Mr. Miller), who shears upwards of 400, has on the average only 6 lb. each, which he attributes to being closer in with the Dishley blood; another neighbour (Mr. Corser), who shears 150, has on the average only 5 lb. of wool each; this flock has in it a dash of the Wiltshire, (a breed very bare of wool). The wool-stapler prefers the 7 lb. fleeces to the 5 lb. at the same price, and indeed objected to giving for the latter more than a guinea per todd, as preferring a good long lock to a shorter staple. Without pretending to much knowledge of manufacture, I have often doubted whether the growth of clothing wool is of more national importance than that of combing; the latter is all wanted, and employs a large population in combing, spinning, and working it in stockings, various kinds of stuffs, flannels, blankets, carpeting,

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and many other things, I am unacquainted with; I believe the true system is to encourage the growth of our best cloathing and combing wools, and to discountenance the bastard or mixed ones. I have often thought, and hinted to farmers, that in the selection of rams for stock, the assistance of a wool-stapler would be of service,* their constant familiarity with wool rendering them much better judges of it than a farmer can possibly be; and it is an object perhaps deserving attention equally with the carcase. The Leicester sheep are much pleasanter pasture stock than any I am acquainted with, producing clothing wool, much more content and quiet in pasture, and from a natural indolence can scarcely be driven about; whilst the other, from a roaming disposition, are often in trespass,† and cannot easily be kept in proper bounds.

I am,

My Lord,

Your Lordship's obedient humble servant,

William Pitt.

My Lord, *Dunkirk, near Bath, Nov. 28, 1799.*

We are favoured with yours of the 23d inst. and are very sorry that your Lordship does not think the patterns of kerseymere sent you, which we made from Mr. Ellman's wool, as perfect as some your Lordship had seen before.‡ The patterns being cut out and pressed before the pieces were finished, they do not look so well as they should do, but when your Lordship sees the pieces, we have no doubt you will approve of them, as we flatter ourselves better was never made with wool of this quality. Your Lordship will please to observe, that we only received 114 lb. of wool in the fleece, to make these pieces with, whereof, had we received a larger quantity to have sorted, we could have thrown the wool finer, as the wool sorters do not throw more than one-sixth part of the prime fine wool from the fleece of the common Southdown wool: we have made from this 114 lb. wool, three fine pieces, white, buff, and black, $104\frac{1}{2}$ yards, and from the second sort, a piece of drab colour, 32 yards: we have left coarse wool

* This is an excellent hint: too much attention cannot be paid to it.

† Sheep of any breed, however, will become infinitely more tractable by cotting.

‡ This is an error.—It was supposed to be unequal to the same wool, (a larger quantity indeed) lately worked into fine cloth; these pieces of kerseymere were the first which have come to hand.

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$6\frac{1}{2}$ lbs.; the amount of manufacturing of which comes to . Your Lordship has been misinformed,* that the Southdown wool is most clear from dark hairs, and most proper for white and buff kerseymeres; the Southdown sheep have more black about them than any other of this country; therefore, the cloths cannot be so clear; the Hereford wool is much better for that purpose. Any farther information we can give your Lordship on the subject, will be imparted with pleasure, by

Your Lordship's

Most obedient servants,

THOS. JOYCE and Co.

However fortunate an investigation of this nature may have been, in engaging the public notice, in calling forth general support, in stimulating the manufacturer to exertion, and in opening the long closed eyes of farmers to so prominent a branch of husbandry, from the months of June to December, much might have been in agitation, but little in so short a period could well be proved. It becomes a duty, however, in the PRESIDENT of the BOARD of AGRICULTURE, with no less gratitude than pleasure, to point out the consequences which have absolutely resulted. Spanish wool, which, in the month of April, was above 5*s.* 3*d.* and daily advancing in price, has gradually fallen to 4*s.* 6*d.* per lb. and is yet falling: here is a positive profit to the manufacturer in his raw article, of one fifth, which must call down shame on those who persist in the late advance of 2*s.* per yard, on foreign cloths, facetiously termed, superfines.

In opposition to which, the visible improvement in the manufacture of British cloths, even in a few months, before any correspondent improvement in native wools could have taken effect, must tend to counteract any attempt at monopoly in foreign

* The clothier whose information is here alluded to, did not consider himself well instructed in the properties of Southdown wool, and referred his correspondent to those more in the practice of working kerseymeres. He was not correct in his ideas as to dark hairs, which must materially injure the sale of these wools for light unmixed cloths, and therefore demand the closest attention of Southdown breeders. A piece of cloth just now manufactured for Mr. Ellman of Glyn, from his own wool, will, on inspection, raise Southdown wool in the estimation of every manufacturer in the kingdom, for the fine cloths of dark colour.

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wools; the dread of which has hung like a millstone about the neck of clothiers, which threw the workman out of employ, and brought his distressed family on the overburthened parish for relief. Such has been the obvious result, so much in this short space of time has been realized to the manufacturer;* whilst Spanish wool, in spight of

* Objections to the doctrine here recommended, were lately attempted in a treatise called, "An Answer to the President's Address to the Board of Agriculture, on Sheep and Wool." The following extract from its reply, just published, may probably throw some light on the subject now under consideration. The author of these objections, splenetic at the rise of British wool, uncandidly taxes the President with suppressing such answers in his address to the Board, as did not militate in favour of his propositions; to which the reply was as follows: "The person alluded to, a very respectable clothier, was applied to by the President, to make a piece of kerseymere: no information was wanted, no comments, but simply kerseymere. The answer was returned subsequent to the delivery of this address, and therefore could not form a part of it. This gentleman's letter cannot be made public, because it was his particular request that it should not: but the substance of the President's answer was as follows: "That superfine clothiers had long been in the practice of working cloths too costly for home consumption, and too coarse for the prejudices of a foreign market; that on this account, the French wrested from them the Levant trade; and if that country was ever in a situation to resume her commerce, they would again lose it from the same cause, should the present system be perservered in." Such an opinion may not be grateful to the superfine clothier; but let him take it as it was meant, to serve, not to injure, and let him give it serious consideration. The ill-timed ambition of France, and the gallantry of our countrymen, have restored to them this branch of commerce in its fullest extent. The French nation has ever been deemed excellent at inventions, and Great Britain at improving on them;—here is a solitary instance of the reverse. The loss of this trade, about the year 1750, so prejudicial to the interest and reputation of Great Britain as a commercial nation, has been attributed to fraud, in stamping pieces of cloth as containing such a quantity, but falling short of measure. This could not have been the case! The good faith of British merchants is proverbial over the whole world; and although such an individual instance might have occurred, in the aggregate of great commercial intercourse between two nations, such a thing is improbable in the highest degree.

The mode of dress in the Turkish empire, and the heat of its climate, rendered heavy cloths, however well manufactured, insupportable; France saw this, and threw in a more flimsy perhaps, but lighter cloth, therefore more suited to the market. Our climate is variable and raw, and our dress demands a stouter cloth. In possession of a certain market for fine cloths of foreign growth, should we not give encouragement to our native wools by every means in our power? We want not these fine cloths; we are not disposed to adopt the Turkish dress; why then should we, like fools, pay the difference in price between the foreign and native cloths? There is very little difference in the wear of the article, consequently in the quality, but there is great difference in the price. Let the clothier, therefore, pay with one hand to the Spaniard, and receive with the other from the Turk, who wants it, and will

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paragraphs in newspapers, and puffs without end, was gradually sinking to its true relative value, British fine wools have risen *6d.* and *7d.* per lb. which leaves a

gladly purchase it. Import the article raw, and export it again manufactured; this is the spirit of trade! so let our manufacturing poor be fed, and the nation enriched.

Again, to defeat some ill-grounded, but specious objections, the reply says, "If this author be not the hireling of some disappointed speculator, it is a matter of regret he should reason so well on such false and narrow principles. Why annihilate any established manufacture from speculative schemes of alteration? If he forget, which it is hardly possible an enlightened manufacturer writing on such a subject should, let him be reminded, that there are fens, marshes, and commons now lying unproductive, to a very great extent, capable, when the spirit of the landed interest shall be roused, of giving immense supplies to the coarse as well as fine woollen manufactures."—The following passage of the address must have escaped the author's notice:

"In the application of the different breeds of these useful animals, to different countries, soil and climate are absolutely decisive; and where these circumstances are forgotten, disappointment follows. It is the height of folly to push any particular breed where these are not congenial; and this argument is conclusive to all who clamour against the introduction of one breed, lest it might injure another, for, whilst we daily see so many commons stocked with loss instead of profit, and the dry fallow system is yet to be found in any part of the kingdom, (the wettest clays excepted), every good breed in the island may look to extention, and the nation to increased wealth."

Has he never heard of Long Sutton Fen, 7,000 acres; King's Sedgemoor, 11,000; New Holland Fen, 10,000 acres; besides numberless others too tedious to enumerate? These drained and inclosed, will carry six heavy coarse wool sheep per acre for half the year, and two per acre the other half, or probably more, yielding 6, 7, and 8 lb. of wool each. Examples such as these suggested themselves at the moment, and therefore may not be correctly stated; but they are nothing in comparison with the many reclaimed within these few years, the many now reclaiming, and those lying yet unproductive, a curse rather than a blessing to their country. What supply is now derived from the commons of Surry, of North and South Wales, of Westmoreland, Cumberland, and Scotland, compared to what these districts enclosed, or farmed even in their unenclosed state, on better principles of husbandry, would give? What quantity of fine wool would not Dartmoor and Exmoor carry under proper management? As an instance of what the latter can do, in its present state, an experienced wool-sorter, some weeks ago had occasion to sort, for the purpose of making broad cloth, the fleeces of fifty native ewes, 2½ lb. each, and to produce as many pounds equal in quality, of Exmoor wool, he declared it necessary to pick nine packs, or sheets, 240 lb. each, although the Exmoor sheep are somewhat smaller in size, and the soil and climate of this moor, and its environs, capable of producing wool inferior in quality to no breed whatever, provided the treatment of sheep were such as reason and nature plainly dictated. Nor ought he to forget, the increase of sheep stock in the convertible and tillage lands of this kingdom; from the now general use of green winter food, and artificial grasses, to what an extent this is gone, and how it is daily extending. One is led to wander beyond due bounds, regretting that this helpless manufacturer, and desponding writer, did not see, or seeing,

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balance in favour of our own wools, of 1*s.* 7*d.* per lb.; they to this hour retain their price. This circumstance alone, speaks the concurrence, without denial, of the public at large; and is of itself sufficient hereafter to secure every attention in farmers to the quality of wool. Observation too must be had to the period which called for an adoption of such measure: the whole Levant market was just then opened to our manufacturers, which might have caused a rise on British, but never could have produced a fall in the price of Spanish wools.

The average prices of native wools are nearly as follows

		s. *d.*	28 lb.		*s.* *d.*
Long Wools	Lincoln, - - - - -	20 0	per tod,	or	0 8½ per lb.
	Leicester, - - - - -	21 6	per do.	or	0 8¼ per do.
Short Wools.	Norfolk, - - - - -	48 6	per do.	or	1 8¼ per do.
	Southdown, - - - - -	-	-		2 10 per do.
	Hereford, trinded, according to Act of Parliament,		from 2*s.* 5*d.*	to	3 0 per do.
	Wools of the Worcester and Shropshire commons,		from 1*s.* 9*d.*	to	2 0 per do.

from North and South Wales, generally speaking, from Exmoor, Dartmoor, &c. too low to be here enumerated, bearing a rise, however, proportionate to other short native wools, and destined to the same manufactures: one instance, however, may be given; the extent of this last mentioned, Dartmoor, is well known, an object, from its magnitude, of national importance; its wool is, at this time, worth about 7*d.* per lb. whilst

did not choose to go thus far into the subject;—and in conclusion it says, that "The address of the President of the Board of Agriculture, the outcry at the different wool fairs of the value of English wools," and the eclat, (as this author expresses himself), may lead to great improvement in the quality of British wool: there is no doubt but the nation will be enriched; that the manufacturer may profit materially as well as the farmer, is devoutly to be wished, nor will any enlightened man doubt it. In the mean time, the writer, in his concluding passage, reckons without his host: if he be the West Country manufacturer he calls himself, then he knows what a demand there now is for fine cloth of native produce, in his own neighbourhood; he knows that all ranks of people are resolved to support a measure, so obviously prejudicial to none, but beneficial to many; and he knows that London, by December next, will be filled with British cloths for British cousumption. Jealousy, perhaps, lest the Yorkshire narrow cloths should now find more than their due encouragement, may form a leading motive in this author's ill-timed opposition; but he need not be alarmed, he may work narrow instead of broad cloths, and no customer will know or care from whence it comes. It may be found as easy to manufacture goods in the shape of narrows as of broads, and infinitely more profitable. Let him then pluck up courage, lay aside his pen, take up his shuttle, and there is little doubt but his cloths will equal, if not excel in texture, his arguments.

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Herefordshire wool, by a partial attainment of the Spanish system, with few, if any other, advantages, sells for 2*s.* 6*d.* per lb. by the fleece, nearly four-fifths more. What wool sheep of this sort carry, is " breechy," that is to say, long and coarse on the haunches, where warmth is not wanted, thin and wiry on the back and loins, where warmth is most essential to the health and profit of the animal itself. If such be the effect of cold and hunger in the southern, how much more caution is demanded in the northern latitudes of this kingdom? The necessity of warmth in many parts of the north is admitted, and after a manner obtained, at the expence of the wool indeed; tar and butter are rubbed in at a considerable prime cost, by which the wool is closed on each side the animal, forming a sort of pent house. How tender the spinal marrow of every animal is, need not be brought just now to our recollection; this tarring and buttering is well meant, and if it be not too expensive, if it does not injure the wool, and by the exposure of the back to rain and snow, endanger the health of the whole flock, it would be an excellent method. Hopes are entertained that a substitute for such treatment can be offered to notice, productive of much good effect. Few commons, if any, pay better than that of Morf, which will appear by reference to Mr. Pitt's letter of July 27th. Here he admits that no return can be reckoned on beyond the wool, because all profit in the carcase must go to support these sheep during winter. If then, on our most productive commons, sheep are kept for their wool, how can we account for such general and ruinous neglect of that produce for which alone these animals are kept? A mere statement of these facts will warrant us perhaps in concluding, that we ought not only to inclose our sheep, but also our commons, such, that is to say, as will pay for inclosing.

The reader's pardon is solicited, if somewhat more be said on a subject hinted at in the address.——Every day's observation must add to our regret, that salt is not a component part of the food of stock, of sheep more particularly. How many diseases arising from damp climate, from relaxation, and from rank green food, might it not subdue! Our duty on salt forbids even the smallest waste in its application, but by no means precludes its use. The ingenious, and no less benevolent, Count Rumford tells us that in Germany, salt is universally given to oxen and cows in a fatting state, and that their proof is proportionate to the quantity given. We are all sensible of the effect of salt on the human body; we are told how unwholesome, we know how unpalatable, fresh meat and vegetables are without it. The ancients held it in the highest estimation, " Omnis mensa male ponitur absque sale." We also know the avidity

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with which animals in a wild state, seek the salt-pans of Africa and America, and the difficulties they will encounter to reach them; this cannot arise from accident or caprice, but from a powerful instinct within, which, beyond control, impels them to seek, at all risks, that which is salubrious, and laughs to scorn the speculative opinions of us weak mortals. But if we must look to old usage, and dare not seek the untrod path of nature and common sense, is it not notorious that hay, mouldy from rain, is rendered palatable, and infinitely nutricious to cattle, by simply strewing salt on the stack, at the rate of 10 or 15 lbs. per ton, when making? Equally notorious is it, that a sensible effect is hereby produced to the taste, that cattle will prefer it to better hay, well put together, and will demand, when fed on it without injury to themselves, three times as much water; which circumstance alone, accounts for that aptitude to fatten, which is never denied to hay so salted.

The President is little disposed to recommend that to the adoption of others, which he will not himself put in practice: he was staggered, as every other man will be, at the price of salt, which cannot, with the duty, be rendered at much less than per ton; but from a perfect conviction, that, by its effects, a threefold interest will be returned, he is resolved in future to bestow from 5 to 20 lb. of salt on his hay for store, and fat cattle, varying the quantity, as seasons are more or less propitious; also, from 50 to 70 lb. per ton on sheep hay, which ought to be of the shortest and sweetest herbage: this will amount to about per ton; the expence therefore is trifling. As far as concerns its application, salt cannot be conveyed into the animal in a more effectual manner than by sprinkling it on hay through a sieve, when in the act of putting together; for every particle is imbibed in the fermentation, without a possibility of waste. It will, no doubt, on trial, prove a better breakfast than those cold dews which prevail in this country nine months out of the twelve. Dews are more prejudicial to the wool and carcase of those feeble animals than has been hitherto considered. The ill effects of green food so counteracted, the consequent increase of nourishment in such food, and the operation in this variable climate, of a more equalized temperature of air, must hereafter become objects of the closest attention; the result cannot be doubted. Let it not be surmised, that any thing suggested on the carcase, and its management, be foreign to our subject,—improvement in British wool; this error has lived too long; it must be heard of no more. That which effects the one, must effect the other; for both are fed from the same store, both are operated on by climate, both by food. Other modes by which ductility and softness may be given to our wool, qualities in which only we are

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deficient, have not escaped notice. Trials of this sort are now making by some skilful farmers, the result of which shall be recorded.

In conclusion then,—Few propositions, unaided by artifice or oratory, appeared more calculated to provoke the utmost opposition of prejudice and indolence; none have been more kindly received. The motives of an humble and well intending individual have stood his friend; the seed has been allotted to good ground, and bountiful now, beyond a doubt, will be the harvest.

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XXIX.

On IRON RAIL-WAYS. *By* J. WILKES, *Esq. of Measham.*

MY LORD,

I TAKE the liberty to send the enclosed. The more iron rail-ways are known, the more they will be used; if properly adapted to various situations. We now are about forming a small Society of Agriculture at Measham, on such a scale as your Lordship's letter recommends.—I transmit to you the particulars of the weights one horse will draw on the road.

Am, your Lordship's

Most humble servant,

JOS. WILKES.

August 2, 1799,
Measham, Atherstone.

Iron Rail-ways.

THESE are a subject of much importance to the landed and commercial interests of this country. Improvements on the system have succeeded each other with wonderful rapidity, and how far their advantages to society may extend, cannot be estimated. The following experiments, made at Measham in the county of Derby, will sufficiently elucidate the very great advantages likely to result from their adoption, particularly in situations where the greatest part of the loading is to be conducted one way, and that with some small degree of declivity.

An agent of the Grand Junction Company, Mr. Homer, attended at Measham, on July the 27th, in order to have ocular demonstration of the superior advantages of a rail way as a land conveyance, and of the weight capable of being drawn by one horse.

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On a part of this road, where the declivity is $\frac{1}{11}$ of an inch in a yard, one horse drew 13 waggons, which, with their loading of coals, amounted in the whole to 22 tons; this he performed with great ease, conveying them to their place of destination, the Ashby canal; no more loaded waggons were then at hand, otherwise more would have been added, but Mr. Homer felt satisfied with the experiment. This horse, it must be observed, drew with as great facility up the acclivity of $\frac{1}{11}$ of an inch in the yard, a weight more than equal to the empty carriages. On the 30th of the same month another experiment was made on the same road, in the presence of the Earl of Moira, and several gentlemen, where one horse drew 19 carriages, which, with their loading, amounted to 30 tons: this astonishing weight the horse did not seem to labour at, more than other horses at ordinary work. The above experiments have given rise to various conjectures, as to what weight would actually overpower the horse on that situation, or what weight he could move on this road, compared with what he might move by a boat on a canal. In order to have the public mind satisfied on this point, some gentlemen mean to attend at Mr. Wilkes's colliery at Measham, on Thursday, the 15th of August, from eleven o'clock till two, at which time a convenient number of carriages will be provided with their respective loads. The weight that has been removed by one horse on this declivity of an iron rail-way, appears so astonishing to some people, that it almost requires ocular proof to convince them of the fact.

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LETTER II.

My Lord,

In reply to the letter I had the honour of receiving from my Lord Winchilsea, of the 25th ult. respecting experiments made on rail-ways, I inform you, that on the 14th of August, one day previous to that mentioned in my note, a party deputed from the committee for conducting the concerns of the Grand Junction Canal, with other gentlemen, attended at my colliery at Measham, in Derbyshire, for the purpose of obtaining ocular and satisfactory proof of their utility, previous to that company adopting them, (which they have now done), in lieu of some portion of their line of canal. The result of the experiments was nearly thus: One horse of the value of £20. on a declivity of an iron road $\frac{5}{16}$ of an inch at a yard, drew 21 carriages or waggons laden with coals and timber, amounting in the whole to 35 tons, overcoming the *vis inertia* repeatedly with great ease; the same horse, up this acclivity, drew 5 tons with ease; he also drew up the road, where the acclivity was $1\frac{3}{4}$ of an inch at a yard, 3 tons; but on this declivity it is necessary to slipper or locks the wheels, the horse not being able to resist the increased momentum of more than 3 or 4 tons.

The same gentlemen proceeded the next day to another colliery I have at Brinsley, in Nottinghamshire, where one horse, value £30. drew, on a road of the same construction, where the declivity was $\frac{2}{5}$ of an inch at a yard, 21 waggons of 5 cwt. each, which, with their loading of coals, amounted to 43 tons, 8 cwt.; the same horse drew 7 tons up the road. It must be observed, that in both the foregoing statements, the cwt. is 120 lbs. On this road, the rails are 3 feet long each, 33 lbs. weight, and calculated to carry 2 tons on each waggon, laid 4 feet 2 inches wide, on stone or wood sleepers, placed on a bed of sleck, so as to fix it solid and firm. The expence of completing one mile of such a road, where materials of all descriptions lie convenient, and where the land lies tolerably favourable for the descent, will be about £900. or £1000. per mile, single road, fenced, &c. exclusive of bridges, culverts, or any extra expence in deep cutting or high embankments. Rails are made from 20 to 40 lbs. per yard, agreeable to the weight they have to bear.

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By the introduction of iron rail-ways, constructed on the best plan, canals may extend their useful influence in enriching and improving the country to a distance of 10 or 20 miles on either side of them, into high mountainous countries, where canals are almost impracticable; instance the rail-way of the Peak Forest in Derbyshire, which joins the Ashton canal, the road from Denbigh to near the town of Derby, and a great many others. In numberless cases, near large towns, they would, no doubt, be of the greatest utility; as from Paddington and the Thames, to different parts of the metropolis, to convey merchandize to and from, as well as speedily and easily take off nuisances from the town, cause less wear to the streets, and prevent many disagreeable consequences arising from the great number of heavy burthened carriages crowding together.

In a great many instances it will occur, where a rail-way, either connected with a canal or not, will be the mode of a cheaper conveyance than water would be; it clearly appears in this case of the Ashby canal, that their rail-way, which is now executing, and a double one, will cost $\frac{2}{3}$ds less than a canal would have done in the district of their rail-way, where the ground for a canal is unfavourable, and furnish the article of lime, which it is principally intended to convey, at $\frac{2}{5}$ths less than a canal would have done, though it is an ascent for some miles on the road; so it is with the Peak Forest, Derby, &c. In short, wherever the quantity of goods to be conveyed on a rail-way, having a descent of not more than $\frac{1}{2}$ an inch in a yard, amounts to $\frac{2}{3}$ds of the weight, as downgate loading, it is a doubt if it will not, in that case, be a cheaper conveyance than a canal; if dispatch is necessary, a rail-way is more certain than a canal, being far more easily repaired; neither does frost or dry seasons affect the trade thereon.

Iron rail-ways have been used for some years in Shropshire, and other places, but for want of a proper system in the forming and laying of such roads, they have been found of little or no more service than wood rail-ways, which, from the late improvements in iron-roads, are now in disrepute.

The leading principles of iron roads are, that the ground should be formed true, making a *perfect inclined plane*, made dry by cutting back drains, soughing, &c. Sleepers of stone, rather than wood, on which the rails rest, and which should be firmly fixed on a bed of stone beat small, the horse path filled with good small hard materials, rails 3 feet long each, weighing 33 lbs. to carry two tons, and laid not less than 4 feet wide.

Iron roads constructed on this plan, which, I apprehend, is yet far short of the per-

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fection they will arrive at, for the carriage of heavy goods to and from large commercial towns, in conjunction with canals, will evidently be of great national advantage; and if the turnpike roads through the kingdom were made on the concave system, agreeable to that which I had the honour to transmit to the Board some time since, the first principle of which is to have a *perfect inclined plane*, a considerable revenue might be derived by Government therefrom, without a tax upon the public. Repairs would be very trifling, owing to water becoming the principal repairing agent; the traveller would be expedited from the smoothness of the road, and more secure from accident; the commerce of the kingdom speedily conveyed from one point to another, and the farmer would be benefited by the advantage of a rich wash, which might be easily conducted from the roads, over his fields, perhaps in many cases equivalent to the maintenance of the road.

I am,

Your Lordship's

Most humble servant,

Jos. Wilkes.

Measham, Feb. 12, 1800.

P. S. I take the liberty to inform your Lordship, that for more than twelve months, I have made it a practice to carry out the dung from the stables and sheds quite fresh, and have found it to be much more beneficial, than any plan for manuring land with dung; and by bringing it to immediate use, I conceive it to be 20 per cent. preferable, to the plan of stacking it for six months till rotten.

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XXX.

An Abstract *of* Baptisms *and* Burials, *in Four Parishes of Fifty Counties in England; collected by Sir* John Call, *Bart. and communicated to the Board of Agriculture, with an Address, dated 21st. February,* 1800.

To the Rt. Hon. Lord Somerville, *President, and the other Noblemen and Gentlemen, Members of the Board of Agriculture.*

My Lords and Gentlemen,

The uncommon scareity of bread corn and butcher's meat which took place in the year 1795 and 1796, and occasioned so much distress throughout the nation, and so mueh expence to Government, by the vigorous measures taken to alleviate that distress, impressed my mind with ideas, that, besides the defieiency of crops by the contingency of seasons, there must be some other great operating cause, which might tend annually to produce something like scarcity, and from time to time, when the crops should be in any degree defieient, beget proportionable distress. It was generally allowed, that great improvements had been made in agriculture, by application of proper manures to the soil, by eonsistent rotation in crops, by inclosures, by other instances of rural economy in the management of farms, and construction of implements, and particularly by an enlarged cultivation of potatoes, which afforded both wholesome and nutritive substistence for man and beast; yet under all these cireumstances, with a total change, in the course of a few years, from exportation of grain, to a progressivive increase of importation to a very considerable amount, the price rose, and seemed likely to keep up, beyond the fluctuation of former times.

Bearing these things in mind, and allowing for their full effect, I deliberated in what manner I should satisfy myself, whether an increased population had not been the principal cause of the scarcity whieh had happened, and whether a progressive increase of the same nature might not keep us in annual expectation of the like event.

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I was not ignorant of the difficulty that would occur, or the objections which might arise, in fixing the state of population at any past period, or determining the increase, or decrease, throughout England, as near as possible to the present juncture. With much trouble, and persevering zeal, Sir John Sinclair had just completed, and made public, a statistical account of Scotland, in which the population was ascertained in the most authentic manner; but no such document was to be met with in England; and the undertaking to obtain it, was too formidable for any individual to attempt, on the same detailed principles, and even Government might have failed. As far as analogy might go, or a comparison of small things with great, I resolved, in the year 1797, to ascertain whether population had increased or decreased, in a small circle of parishes, in the counties of Devon and Cornwall, around my residence; and having settled a form, for making an abstract of baptisms and burials, in each year, I requested the assistance of the ministers of 28 parishes to furnish me with extracts from their respective registers. When these were collected, I formed a general abstract of the whole, the result of which, with some relative observations, I had the honour to lay before the Board, on the 4th May, 1798; and by this investigation, it appeared, that the baptisms in the established church, during a period of the preceding 10 years, amounted to 6956, while the burials, including all descriptions of sectaries, amounted to 4645, or about one-third excess, of the number baptised. This was an excess much beyond what I had expected, and I could hardly persuade myself, that an increase in the same ratio had taken place throughout England.

Although I was wholly blind, and thereby greatly disqualified for an extensive correspondence, yet having taken a first step in a project which dwelt forcibly on my mind, I resolved to extend my inquiry throughout England, by obtaining, if possible, authentic extracts from the registers of four dispersed and distant parishes in every county. With this view, I prepared a general form for inserting the annual baptisms and burials, which I sent with circular letters explaining my motives, to some Bishops, Noblemen, County Members, and other gentlemen residing in the several counties; or to the Rectors, Vicars, or Curates, with whom I happened to have any acquaintance. It may readily be conceived, that it was no easy matter to find out correspondents through so extensive a line. I was accordingly prepared to encounter some difficulties and delay, especially as the members, and many gentlemen, were absent from their respective counties, on the service of their country, with the militia; but although the delay has exceeded what I reasonably hoped for, I thankfully acknowledge my obligations to all

that description of persons above named, who answered my request as expeditiously as I could have expected, or as soon as it was in their power.

Having thus described the motives and steps by which I was led to engage in the present undertaking, I beg leave to refer the Board to the Abstract which accompanies this Address, containing the substance of the returns which I have received, without predilection on my part, from four parishes in fifty counties of England, arranged alphabetically. I have designedly omitted any inquiry in Middlesex, because the bills of mortality furnish information much more particular than I could have obtained, and because the cities of London and Westminster receive continual additions of inhabitants from every part of the kingdom; and commerce occasions the resort, by shipping, of many foreigners, some of whom are, doubtless, buried in the neighbouring parishes: but if one may judge from the ground occupied, and number of houses built, in the environs of the capital, within these last ten years, the increase of population, by baptisms, must have kept pace with any other part of the kingdom. The county of Flint stands vacant in the Abstract, because I have not been able to obtain any returns from that county, (for what reason I know not,) either from the Bishop of the diocese, or Member for the county, to whom application has repeatedly been made, and in expectation of which, I have delayed this address two or three months.

It seems unnecessary for me to use any arguments to prove, that on the face of the Abstract, there has been an increase of population, as far as the baptisms exceed the burials, supposing the comparative totals of these two classes are admitted as a fair criterion to judge by. If, however, this should be denied, I know not where to find more irrefragable proof, or any better ground to decide on; and shall, therefore, assume the data I have collected, as the sources from which I must draw my conclusions.

The total of baptisms is, 73,635, and the total of burials, 50,142, which, corrected and taken from the baptisms, leaves an excess of 23,493, or near one-third upon the whole number of baptisms. But as the total of burials includes the deceased of every description of persons who dissent from the Established Church of England, and few, or none of those are included in the church register of the baptisms, a proportionable number should be added thereto, or deducted from the burials;—what those proportions ought to be, I leave every reader to form his own judgment, contenting myself with saying, that, in my own opinion, it would make the excess of baptisms much above one-third of the whole number. I doubt not, but arguments may be brought forward, or objections made to this mode of deciding on the increased population of England,

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but I will not undertake to answer by anticipation, all that ingenuity, or a disposition to con roversy, may suggest; I will, however, endeavour to obviate one, which occurred to me; I mean, that it may be urged, great numbers of males in particular have died, been killed, or lost by land or sea in the service of their country. To ascertain what that contingent might be, I could devise no better method, than to have recourse to the totals at the bottom of the Abstract, where the number of males baptized exceeds that of the females, by 1687; and yet the number of females buried, is more than the males by 438, which add to the excess of males baptized, makes a difference of 2125, which I will admit have emigrated, been lost at sea, or died abroad, in the course of the ten years, which taken in gross, is about 1 in 11 of the apparent increase; and such an allowance, I am persuaded, will more than cover the loss of males by the war, by an extended commerce, and by providing for the defence of our foreign possessions. Various and essentially different have been the calculations, which have been made of our population by political writers, in the course of the present century; so that I will not venture to assume whether we amounted to 7, 8, 9, or 10 millions in the beginning of the year 1788. All I shall beg leave to have granted is, that the increase has not been less than one-third part, in the course of ten years, to the end of the year 1797, on the total, whatever it might have been at the beginning of the period; and the increase of the population has been regular and progressive for thirty years past, if not for more; of which circumstance I have satisfied myself, by getting extracts from several parishes, of the marriages, in periods of ten years, from the beginning of 1770, to the end of 1799, by which I find the increase of marriages in the last period, is about one-third more than what it was in the first.

By what I have already stated, I hope enough has been said to establish, beyond contradiction, that our population has increased, and is increasing; I cannot add, that it ought to be diminished, but I will venture to assert, that it ought to be provided for. A difference of opinion, perhaps, may arise amongst those who discuss the subject, as to the cause and source of this increase; and, probably, there may have been a combination of circumstances operating more or less to produce it; but the most efficient, in my mind, is the general introduction and practice of inoculation, throughout the kingdom, for the last forty years; and, in country parishes at least, the more frequent marriages of labourers and mechanics, who, instead of living with their employers, as covenant servants, have, for some time past, undertaken *tet-work*, or worked for daily hire, being most of them married, living in separate cottages, and having, in general,

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many children; the progressive increase of the poor rate, is a corroborating proof. As I have not presumed to fix the number of inhabitants which were to be fed in this kingdom at any former period, or are to be fed now, I cannot assume the quantity of bread corn requisite to feed them, and the number of acres to be kept annually in tillage for that purpose; but as I must have some datum to reason upon, from analogy, I will beg leave to assume, that the number of souls were 8 millions at the beginninng of the year 1788, and allowing, at least, 6 Winchester bushels of bread corn for the annual consumption of every man, woman, and child in the kingdom, it would require 48,000,000 of bushels; or, on an average, a tillage of 2,400,000 acres, to produce a sufficient quantity of corn; and, supposing the population now, at the end of the 18th century, to be only 10,500,000 souls, the quantity of bread corn necessary for their ordinary subsistence, would be 63,000,000 of Winton bushels, and the tillage to produce that number of bushels, 3,150,000 acres. I state this to be requisite in wheat and barley, independent of the grain consumed by distilleries, breweries, in powder, starch, and paste, which in point of quantity must be very considerable; for in proportion as population and luxury have increased, the consumption in these articles has been adequate, and I do not believe that the importation of grain has kept pace with the expenditure, under these heads; so that whenever it has happened that the harvest has not yielded an average crop, scarcity and distress have ensued in every department that required grain for its operation—and we have been driven to the necessity of seeking substitutes and supplies from every quarter of the globe, at whatever expence they could be procured.

It is an axiom, I believe, generally assented to, that population will continue to increase so long as provisions can be raised on the soil, or procured on reasonable terms; and it is equally true, that population is checked by poverty, and cannot extend beyond the limits of reasonable subsistence. Let every one, therefore, who considers this subject, form his conclusion of what our situation will be ten years hence, unless some proper measures are taken to meet the exigence.

Were the subject new, or now under discussion, it might easily be shewn how much the riches, the comfort, the strength, the exertion of ingenuity, the superior excellence of manufacturers, the exsention and protection of commerce, depended on the cultivation of the soil possessed by any nation, so as to produce a reasonable and competent supply of the necessaries of life: but I am satisfied no one will contend against the admission of such a principle, or that this kingdom should be granting a considerable

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annual bounty to other nations, to supply them with bread corn, or in other words, part of their daily bread. I will not extend my arguments or observations as to the consequence of such a predicament; I therefore submit to the experience, the more extended knowledge, and better judgment of the Board, if they should be pleased to adopt my ideas of an increasing population, in what manner, and by what modes the production of bread corn can be increased, in an adequate ratio, without diminishing a competent supply of butcher's meat; for, to a nation accustomed to feed like ours, and having such a variety of articles of convenience and commerce, dependant on four-footed animals, it is as highly necessary to keep up the breed of cattle, sheep, horses, and hogs, as it is to till wheat, barley, oats, rye, beans, pease, and other pulse. Stimulated by the premiums, exhortations, and publications of this Board, as also of the Bath Society of Agriculture, and other provincial societies throughout the kingdom, much attention and emulation has, within these few years, undoubtedly been given to the cultivation of land, and improvement of live stock; but I fear all these incitements will fall short, unless the Legislature opens an easy road to the inclosure of common field and waste land.

I beg pardon for detaining the Board so long, but the important light in which the subject appears to me, will I hope, be received as a sufficient apology from,

My Lords and Gentlemen,

Your very faithful and devoted humble servant,

JOHN CALL.

Whiteford near Callington,
21st Feb. 1800.

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An ABSTRACT *of* BAPTISMS *and* BURIALS *during a Course of ten successive Years, extracted from the Registers of four Parishes in the Counties hereunder mentioned, shewing at one view, the Increase or Decrease of Population in those Parishes, which were taken as far as they could be obtained, where the Inhabitants were, in general, permanently resident, and not drawn together from other Places of Nativity, to carry on any Manufacture, or other particular object; collected, with the Assistance of many Noblemen, Gentlemen, and Clergy, resident in the several Counties, by Sir* JOHN CALL, *Bart. an Ordinary Member of the Board of Agriculture, in the Years* 1798 *and* 1799.

Date.	No.	Counties.	Parishes.	Baptisms.			Burials.			Excess of Baptisms.	Excess of Burials.	Remarks and Signatures to the Returns.		
				Males.	Females.	Total.	Males.	Females.	Total.					
From the 1st of January, 1788, to the 31st of December, 1797.	1	Anglesea	Bezumaris	230	263	493	158	168	326	167		Richard Griffith,	Minister.	
			Llanfaes	17	18	35	17	20	37	—	2	Richard Thomas,	ditto.	
			Penmynydd	50	51	101	34	40	74	27		John Lewis,	ditto.	
			Holyhead	341	337	678	232	219	451	227		William Lloyd,	ditto.	
	2	Bedford	Sandy	171	136	307	125	101	226	81		Ph. Monoux,	Minister.	There are some sectaries who bury but do not baptize.
			Ampthill	156	176	332	112	123	235	97		George Cardale,	ditto.	
			Cardington	124	111	235	110	87	197	38		F. Cumming,	ditto.	
			Meppershall	62	47	109	34	23	57	52		J. Webster,	ditto.	
	3	Berks	Cookham	272	312	584	218	215	433	151		Thomas Whately,	ditto.	
			Farnham	125	155	240	83	85	168	72		W. Roberts,	ditto.	
			Wargrave	210	208	418	129	131	260	158		Ph. Nind,	ditto.	
			St. Mary Reading	374	397	771	412	443	855	—	84	Dr. Dean,	Minister.	There are many sectaries who bury but do not baptize.
	4	Brecon	Talgarth	135	131	266	117	103	220	46		John Morgan,	ditto.	
			Devynock	197	158	355	107	120	227	128		Benjamin Newton,	ditto.	
			Llangattock	118	131	249	86	80	166	83		Henry Payne,	ditto.	
			Llanvair in Builth	57	48	105	60	48	108	—	3	Thomas Morgan,	ditto.	
	5	Bucks	Penn	151	170	321	103	112	215	106		J. Middleton,	ditto.	
			Marlow	486	514	1000	360	418	778	222		Minister not named.		
			Amersham	323	307	627	207	211	418	209		Dr. Drake,	Minister.	
			Fulmer	52	49	101	28	17	45	56		William Nettleship,	ditto.	
	6	Cambridge	Stapleford	28	37	65	21	36	57	8		T. Thomason,	ditto.	
			Cottersham	108	122	230	81	80	161	69		Thomas Key,	ditto.	
			Chesterton	134	128	262	75	85	160	102		W. L. Mansell,	ditto.	
			Hinxton	38	41	79	27	31	58	21		Minister not named.		
				3956	4007	7963	2936	2996	5932	2120	89			

Date.	No.	Counties.	Parishes.	Baptisms.			Burials.			Excess of Baptisms.	Excess of Burials.	Remarks and Signatures to the Returns.
				Males.	Females.	Total.	Males.	Females.	Total.			
From the 1st of January, 1788, to the 31st of December, 1797.	7	Cardigan	Tref Drayne	93	92	185	52	71	123	62		Minister not named.
			Llanfichangel yCroythin	114	107	221	82	61	143	78		Lewis Evans, Minister.
			Llangrannog	58	76	134	33	46	79	55		Evan Thomas, ditto.
			Caron	138	159	297	66	84	150	147		David Williams, ditto.
	8	Carmarthen	Conwil Gaio	211	198	409	79	67	146	263		Morgan Morgan, ditto.
			Llangendeirn	278	238	516	193	187	380	136		James Edwards, ditto.
			Llanegwad	224	200	424	102	144	246	178		John Jones, Minister. Eight or ten dissenters not baptized but buried in the Established Church ann.
			Llangadock	210	237	447	158	166	324	123		John Lewelyn, Minister. Fifteen families who bury but do not baptize in the Established Church.
	9	Carnarvon	Llandeiscolen	182	164	346	102	94	196	150		William Williams, Minister. A few in this parish who bury also but do not baptize.
			Abergwyngregin	66	76	142	34	41	75	67		Hugh Williams, ditto.
			Llanwnda	119	111	230	71	55	126	104		John Williams, ditto.
		Cheshire	Llanfairfechan	93	77	170	44	35	79	91		David Williams, ditto.
	10		Acton	309	322	631	226	255	481	150		J. Carr, ditto.
			Nantwich	623	486	1109	397	409	806	303		Anthony Clarkson, ditto.
			Barthomley	138	152	290	151	147	298	—	8	E. Hinchliffe, ditto.
			Eastham	193	144	337	132	129	261	76		Thomas Trevor Trevor, ditto.
	11	Cornwall	Tywardreth	149	117	266	79	87	166	100		Wymond Cory, ditto.
			Saint Germains	317	326	643	148	154	302	341		Thomas Penwarn, ditto.
			North Hill	111	108	219	55	62	117	102		Edward Rodd, ditto.
			Marham Church	71	85	156	33	47	80	76		John Kingdon, ditto.
	12	Cumberland	Thorsby	65	55	120	57	63	120	—	—	T. Mason, ditto.
			Bromfield	145	114	259	79	71	150	109		J. Martin, ditto.
			Westward	124	121	245	54	63	117	128		Samuel Halifax, ditto.
			Aikton	78	73	151	40	48	88	63		J. Wilkinson, ditto.
	13	Denbigh	Llangollen	378	320	698	176	242	418	280		John Morgan, ditto.
			Llandegla	73	74	147	69	55	124	23		John Owen, ditto.
			Bryn Eglwys	64	54	118	47	31	78	40		Ditto, ditto.
			Ruabon	618	624	1242	382	389	771	471		J. Denman, ditto.
				5242	4910	10152	3141	3303	6444	3716	8	

Date.	No.	Counties.	Parishes.	Baptisms. Males.	Baptisms. Females.	Baptisms. Total.	Burials. Males.	Burials. Females.	Burials. Total.	Excess of Baptisms.	Excess of Burials	Remarks and Signatures to the Returns.
From the 1st of January, 1788, to the 31st of December, 1797.	14	Derby	Alpeton	323	302	625	175	164	339	286		Anthony Carr, Minister.
			Ashbourne	440	414	854	288	322	610	244		J. Langford, Register-keeper.
			Longford	134	147	281	80	76	156	125		Edward Phillips, Minister.
			Repton	179	161	340	117	122	239	101		John Edwards, ditto.
	15	Devon	Bradnich	197	202	399	125	139	264	135		Thomas Tanner, ditto.
			Braunton	168	166	334	108	110	218	116		Sent by Ph. Webber, Esq.
			Hartland	194	207	401	130	129	259	142		William Chanter, Minister.
			Whitchurch	93	96	189	60	39	99	90		Richard Sleeman, ditto.
	16	Dorset	Dawlish	36	50	86	26	41	67	19		John Wood, ditto.
			Whitchurch	57	64	121	29	26	55	66		James Dowland, ditto.
			Durweston & Bryanston	40	55	95	26	38	64	31		Christopher Fleet, ditto.
			Frampton	55	48	103	36	37	73	30		J. Sawkins, ditto.
	17	Durham	Lanchester	405	426	831	267	246	513	318		J. Walker, ditto.
			Easington	137	121	258	102	105	207	51		A. Garthorne, ditto.
			Greatham	83	75	158	66	66	132	26		John Brewster, ditto.
			Stockton upon Tees	556	524	1080	427	508	935	145		Ditto, ditto.
	18	Essex	High Ongar	99	81	180	57	55	112	68		Thomas Darley, ditto.
			Great Baddon	164	165	329	131	125	256	73		Alexander Longmare, ditto.
			Great Hallingbury	79	81	160	50	45	95	65		J. Lipyeatt, ditto.
			Roxwell	114	95	209	61	70	131	78		Richard Birch, ditto.
	19	Flint										The Bishop of the diocese and Member for the county have each been applied to twice, but no answer or returns have been received from either.
	20	Glamorgan	Whitchurch	123	119	242	99	100	199	43		William Davis, jun. Minister.
			Llandaff	140	126	266	95	72	167	99		Dr. Hall, ditto.
			Cardorton by Barry	34	29	63	9	19	28	35		Thomas Price, ditto.
			St. Andrews	78	73	151	44	53	97	54		Ditto, ditto.
	21	Gloucester	Cheltenham	361	323	684	256	218	474	210		R. Misham, ditto.
			Newent	362	360	722	214	223	437	285		J. Foley, ditto.
			Tibberton	34	32	66	21	18	39	27		William Beale, ditto.
			Yate	124	99	223	54	50	104	119		Edward Davies, ditto.
				4809	4641	9450	3153	3216	6369	3081		

Date.	No.	Counties.	Parishes.	Baptisms. Males.	Baptisms. Females.	Baptisms. Total.	Burials. Males.	Burials. Females.	Burials. Total.	Excess of Baptisms.	Excess of Burials.	Remarks and Signatures to the Returns.
From the 1st of January, 1788, to the 31st of December, 1797.	22	Hants	Nursling	69	64	133	43	44	87	46		Robert Cranmer, Minister.
			Millbrook	191	177	368	130	110	240	128		H. Harvest, ditto.
			Eling	428	466	894	265	244	509	385		Dr. Ashe, ditto.
			All Saints (Southton)	251	241	492	201	188	389	103		Ri. Mant, ditto.
	23	Hereford	Ledbury	423	384	807	313	282	595	212		John Kenton Dawson, Minister. The dissenters in this parish bury, but do not baptize, in the Established Church.
			St. Devereaux	37	31	68	13	16	29	39		J. Williams, ditto.
			Dyndor	48	40	88	35	28	63	25		F. Brickendon, ditto.
			Shilpeck	43	40	83	27	18	45	38		J. Williams, ditto.
	24	Herts	Stevenage	206	189	395	168	139	307	88		H. Baker, ditto.
			Hitchin	336	382	718	260	262	522	196		Rich. Blacow, ditto.
			Welwyn	133	97	230	95	86	181	49		— Ellico, ditto.
			Bishops Hatfield	341	386	727	317	282	599	128		John Keet, ditto.
	25	Huntingdon	Brington	16	25	41	6	7	13	28		Charles Favell, ditto.
			Bythorne	47	32	79	31	32	63	16		Ditto.
			Old Weston	68	66	134	55	58	113	21		Ditto.
			Eynesbury	118	97	215	58	62	120	95		Wm. Cole, ditto.
	26	Kent	Chart juxta Sutton	69	74	143	50	48	98	45		J. E. Gambier, ditto.
			East Malling	178	194	372	142	142	284	88		Daniel Hill, ditto.
			Teston	31	25	56	14	10	24	32		J. Kennedy, ditto.
			Langley	17	24	41	16	15	31	10		J. E. Gambier, ditto.
	27	Lancashire	Bispham	81	77	158	43	34	77	81		William Elston, ditto.
			Aughton	156	162	318	92	88	180	138		George Vanbrugh, Minister. There are about 200 Roman Catholics in this parish who bury, but do not baptize, in the Established Church.
			Ormskirk	1139	1063	2202	718	767	1485	717		J. Johnson, Minister. The Roman Catholics and Presbyterians in Ormskirk are very numerous: they bury, but do not baptize, in the Established Church.
			Poulton	465	412	877	301	357	658	219		Tho. Turner, ditto.
	28	Leicester	Sheepy	91	71	162	24	33	57	105		W. Fell, ditto.
			Kibworth	172	150	322	132	137	269	53		J. Goodman, ditto.
			Scalford	50	67	117	35	51	86	31		Sent by Sir E. Hartop—no name of Clergyman inserted.
			Melton Mowbray	268	251	519	182	171	353	166		Tho. Ford, Minister.
				5472	5287	10,759	3766	3711	7477	3282		

Date	No.	Counties.	Parishes.	Baptisms. Males.	Baptisms. Females.	Baptisms. Total.	Burials. Males.	Burials. Females.	Burials. Total.	Excess of Baptisms.	Excess of Burials.	Remarks and Signatures to the Returns.
From the 1st of January, 1788, to the 31st of December, 1797.	29	Lincoln	Epworth, Isle of Axholm	220	243	463	146	182	328	135		Sent by Rt. Hon. Sir Jos. Banks—no name of Clergyman.
			Horncastle	373	325	698	241	181	422	276		J. Tretwell, Minister.
			North Coats	22	22	44	12	9	21	23		Wm. Chaplin, ditto.
			Newsleaford	257	277	534	210	242	452	82		Edward Walerson, ditto.
	30	Merioneth	Llan Illtyd	76	53	129	49	49	98	31		Evan Herbert, ditto.
			Dollgelly	384	329	713	277	290	567	146		Rich. Hughes, ditto.
			Llanfachreth	135	137	272	114	83	197	75		Evan Herbert, ditto.
			Corwen	130	97	227	80	99	179	48		Edw. Roberts, ditto.
	31	Monmouth	Llangattock Lingoid	32	27	59	15	12	27	32		William Moroan, ditto.
			Lanover	187	151	338	64	59	123	215		John Williams, ditto.
			Llantillis Pertholey	88	75	163	69	84	153	10		William Powell, ditto.
			Abergavenny	305	306	611	276	278	554	57		J. Williams, ditto.
	32	Montgomery	Newtown	158	119	277	76	69	145	132		Edward Lewis, ditto.
			Cemmes	113	94	207	63	57	120	87		J. Davies, ditto.
			Llanidloes	302	296	598	165	169	334	264		Ditto, ditto.
			Guilsfield	313	264	577	185	217	402	175		L. Rowlands, ditto.
	33	Norfolk	Holkham	119	87	206	52	66	118	88		Henry Crowe, ditto.
			Brisingham	107	76	183	61	53	114	69		Sent by J. Frere, Esq.
			Wymondham	531	510	1041	286	297	583	458		Ditto.
			Hethersett	114	94	208	50	49	99	109		Bartholomew Edwards, Minister.
	34	Northampton	Great Addington	38	31	69	19	26	45	24		James Smythe, ditto.
			Marston St. Lawrence	51	50	101	32	44	76	25		Sent by S. Blencowe, Esq.
			Maxey	53	65	118	40	30	70	48		White Bates, Minister.
			Ringstead	66	65	131	24	25	49	82		J. Gasharth, ditto.
	35	Northumberland	Simonburn	162	138	300	92	112	204	96		John Buckbarrow, ditto.
			Corbridge	199	161	360	144	171	315	45		Ralph Brocklebank, ditto.
			Bywell St. Peter	99	77	176	90	92	182	—	6	Henry Johnson, ditto.
			Warden	206	186	392	149	148	297	95		John Thompson, ditto.
	36	Nottingham	Cotgrave	120	104	224	74	64	138	86		Henry Smith, ditto.
			Warsop	192	150	342	96	87	183	159		J. Ashpinshaw, ditto.
			Eakring	63	62	125	42	39	81	44		John Henry Brown, ditto.
			Weston	36	33	69	30	29	59	10		Wm. Doncaster, ditto.
				5251	4704	9955	3323	3412	6735	3226	6	

Date.	No.	Counties.	Parishes.	Baptisms. Males.	Baptisms. Females.	Baptisms. Total.	Burials. Males.	Burials. Females.	Burials. Total.	Excess of Baptisms.	Excess of Burials.	Remarks and Signatures to the Returns.	
From the 1st of January, 1788, to the 31st of December, 1797.	37	Oxford	Dorchester	140	143	283	103	81	184	99		Sent by C. Willoughby—no Clergyman named.	
			Marsh Baldon	63	53	116	24	25	49	67		J. Parsons, Minister.	
			Lower Heyford	58	66	124	34	40	74	50		Wm. Filmer, ditto.	
			Whitchurch	105	85	190	68	73	141	49		John Lichfield, ditto.	
	38	Pembroke	Nolton	20	27	47	14	22	36	11		Moses Grant, ditto.	
			Watton East	39	31	70	15	18	33	37		James Thomas, ditto.	These two are adjoining parishes.
			Stackpole and St. Petroz	32	51	83	25	17	42	41		Charles Pigot Pritchett, Minister.	
			St. David's	205	201	406	124	152	276	130		Del. Pritchett, ditto.	
	39	Radnor	Knighton	138	125	263	104	113	217	46		Robert Davies, ditto.	
			Cliro	94	97	191	70	75	145	46		Edward Edwards, ditto.	
			Boughrood	41	38	79	17	18	35	44		Benjamin Howell, ditto.	
			Nantmel	117	86	203	59	62	121	82		W. Williams, ditto.	
	40	Rutland	Empingham	134	111	245	66	59	125	120		Robert Blyth, ditto.	
			Uppingham	209	218	427	141	174	315	112		Edward Jones, jun. ditto.	The Presbyterians and Methodists in this parish bury, but do not baptize, in the Established Church.
			N. Luffenham	58	51	109	39	40	79	30		Thomas Wilson, Schoolmaster.	
			Oakham	223	214	437	157	163	320	117		Rich. Williams, Minister.	
	41	Salop	S. Hales and Woodcote	178	158	336	108	86	194	142		Robert Dean, ditto.	
			Edgmond	188	148	336	91	79	170	166		Richard Foy, ditto.	
			Astly Abbots	74	60	134	44	31	75	59		John Williams, ditto.	
			Newport	284	265	549	192	219	411	138		J. Langley, ditto.	
	42	Somerset	Halse	57	67	124	32	41	73	51		Thomas Cornish, ditto.	
			Fitzhead	41	60	101	23	27	50	51		J. Farthing, ditto.	
			Melverton	201	216	417	119	127	246	171		W. Darch, ditto.	
			Langford Budville	87	82	169	45	44	89	80		Ditto, ditto.	
	43	Stafford	Blithfield	63	59	122	34	42	76	46		Walter Bagot, ditto.	
			Leigh	140	140	280	88	89	177	103		H. Thomas, ditto.	
			Brewood	342	433	775	267	303	570	205		Matthew Kunsey, ditto.	
			Lapley	106	98	204	70	51	121	83		Sampson Webb, ditto.	
	44	Suffolk	Boxted	26	28	54	9	11	20	34		The totals of Baptisms and Burials were taken by ballot from the corrected Survey of this County, by Mr. Young; published in 1797.	
			St. Mary, Ipswich	58	60	118	55	58	113	5			
			Bailham	44	41	85	23	21	44	41			
			Wood Ditton	83	86	169	56	58	114	55			
				3648	3598	7246	2316	2419	4735	2511			

Date.	No.	Counties.	Parishes.	Baptisms.			Burials.			Excess of Baptisms.	Excess of Burials.	Remarks and Signatures to the Returns.		
				Males.	Females.	Total.	Males.	Females.	Total.					
From the 1st of January, 1788, to the 31st of December, 1797.	45	Surry	Epsom	250	206	456	269	180	449	7		Jonathan Boucher,	Minister.	
			Ewell	190	191	381	153	159	312	69		Thomas Lloyd,	ditto.	
			Cheam	68	78	146	71	52	123	23		Henry Peach,	ditto.	
			Kingston	788	677	1465	629	560	1189	276		J. Cundall,	ditto.	
	46	Sussex	Rye	352	337	689	222	197	419	270		D. Pape,	Minister.	Some military having been quartered in Rye for the last 3 years, the ordinary Baptisms and Burials have in consequence been increased.
			East Bourne	281	310	591	168	159	327	264		John Myers,	Minister.	The Baptisms and Burials have also been increased in this parish for the above reason.
			East Grinstead	471	452	923	283	282	565	358		S. Bostock,	ditto.	A camp having been within the limits of the parish, has occasioned an increase of both Baptisms and Burials.
			Battle	259	245	504	142	139	281	223		Dean Terris,	Minister.	
	47	Warwick	Kenilworth	293	246	539	210	213	423	116		Robert Sunmer,	ditto.	
			Tysoe	122	135	257	69	96	165	92		John Seagrave,	ditto.	
			Wellsbourn	152	147	299	79	80	159	140		J. H. Williams,	ditto.	
			Stratford on Avon	484	470	954	383	366	749	205		J. Davenport,	ditto.	
	48	Westmorland	Lowther	63	58	121	39	43	82	39		Wm. Lowther,	ditto.	
			St. Lawrence, Appleby	171	144	315	99	117	216	99		Wm. Phillips,	ditto.	
			Askham	79	76	155	59	57	116	39		Richard Wadsworth,	ditto.	
			Kirkby Lonsdale	437	406	843	290	287	577	266		Sent by Col. Lowther.		
	49	Wilts	Edington	108	101	209	60	74	134	75		Wm. Roots,	Minister.	
			Swindon	168	164	332	118	122	240	92		E. Goodenough,	ditto.	
			Bremham	193	233	426	137	173	310	116		Henry Bamton,	ditto.	
			Pewsey	161	167	328	96	102	198	130		Bryar Mackey,	ditto.	
	50	Worcester	Ribbesford	608	575	1183	343	326	669	514		Joseph Taylor,	ditto.	From these returns it appears that the population and increase in Worcester exceeds that of other Counties.
			Lindridge	177	169	346	100	94	194	152		John Price,	ditto.	
			Rock	187	160	347	115	122	237	110		David Davily,	ditto.	
			Eastham	124	117	241	53	35	88	153		C. Whitehead,	ditto.	
				6186	5864	12050	4187	4035	8222	3828				

Date.	No.	Counties.	Parishes.	Baptisms. Males.	Baptisms. Females.	Baptisms. Total.	Burials. Males.	Burials. Females.	Burials. Total.	Excess of Baptisms.	Excess of Burials.	Remarks and Signatures to the Returns.
From the 1st of January, 1788, to the 31st of December, 1797.	51	York										
		North Riding	Richmond	429	403	832	329	373	702	130		C. Goodwill, Minister.
			Bolton (a Chapelry)	150	91	241	74	86	160	81		Rich. Marly Atkinson, ditto.
			Catherick	146	156	302	108	110	218	84		Ditto, ditto.
			Kirby Moorside	370	371	741	190	224	414	327		W. Comber, ditto.
		West Riding	Pontefract	935	923	1858	628	693	1321	537		J. Bindless, ditto.
			Sherborn	308	317	625	175	199	374	251		Matthew Barker, ditto.
			Womersley	100	86	186	48	59	107	79		John Noble, ditto.
			Tadcaster	387	364	751	298	273	571	180		William Rhodes, ditto.
		East Riding	Hutton Cranswick	130	125	255	76	69	145	110		Extracted by H. Grimston, Esq.— sent by W. Wilberforce, Esq.
			Lockington	48	54	102	51	54	105	—	3	Francis Lundy, Minister.
			Elton	59	49	108	25	24	49	59		John Fox, ditto.
			South Dalton	35	24	59	28	34	62	—	3	Francis Best, ditto.
				3097	2963	6060	2030	2198	4228	1838	6	

TOTALS OF THE PRECEDING PAGES.

Pages.	Baptisms. Males.	Baptisms. Females.	Baptisms. Total.	Burials. Males.	Burials. Females.	Burials. Total.	Excess of Baptisms.	Excess of Burials.
485	3956	4007	7963	2936	2996	5932	2120	89
486	5242	4910	10152	3141	3303	6444	3716	8
487	4809	4641	9450	3153	3216	6369	3081	—
488	5472	5287	10759	3766	3711	7477	3282	—
489	5251	4704	9955	3323	3412	6735	3226	6
490	3648	3598	7246	2316	2419	4735	2511	—
491	6186	5864	12050	4187	4035	8222	3828	—
492	3097	2963	6060	2030	2198	4228	1838	6
	37661	35974	73635	24852	25290	50142	23602	109

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